Features Fusion

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Motivation

Building blocks for the project:

→ Feature*s* extractor*s*: color and shape

→ Classifier

How to combine multiple features extractors?

Outline

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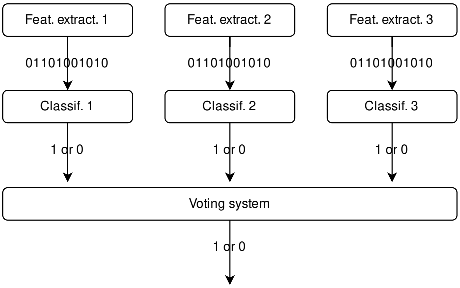
Definition

In late fusion, a.k.a. decision fusion, we process each feature set before making any decision.

Common strategies:

- **voting** (majority, consensus, average. . .)

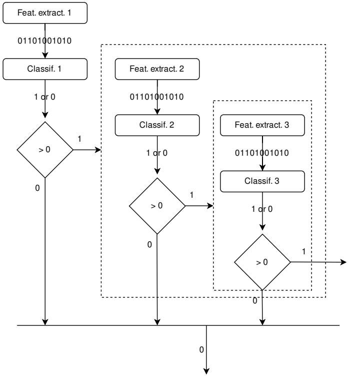


Definition

In late fusion, a.k.a. decision fusion, we process each feature set before making any decision.

Common strategies:

- **voting** (majority, consensus, average...)
- **cascade** of classifiers (e.g. Haar cascade)
  can speed things up



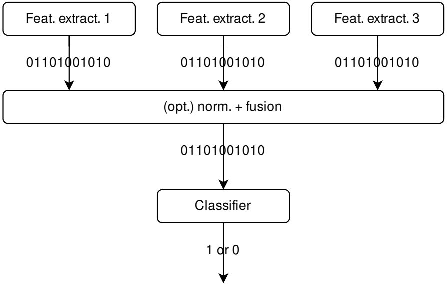
Outline

Definition

In early fusion, a.k.a. data fusion, we merge all features before processing them.

We must fuse all our features into 1 single representation space.
This leads to several problems:

- We may need to convert our features.
- We may need to normalized our features.
- We must aggregate our features.



Some examples:

- Qualitative $\rightarrow$ Quantitative
- Int $\rightarrow$ Float32

Some examples:

1) Min-max normalization

Scaling using minimum and maximum of each feature component

Highly sensitive to outliers

Min-max $$X_i' = \frac{X_i - min(X_i)}{max(X_i) - min(X_i)}$$

Some examples:

2) Z-score normalization

Scaling using arithmetic mean μ and std deviation σ of each feature component
One of the most common normalization techniques
Also sensitive to outliers

Z-score $$X_i' = \frac{X_i - \mu}{\sigma}$$

Some examples:

3) Tanh normalization

Also computed using μ and σ

More robust and efficient normalization

Tanh $$X_i' = \frac{1}{2}\left\{\tanh\left[0.01 \cdot \left(\frac{X_i - \mu}{\sigma}\right)\right] + 1\right\}$$

Some examples:

4) MAD normalization

- Computed using the median and median absolute deviation
- Insensitive to outliers and the points in the extreme tails of the distributions

MAD $$X_i' = \frac{X_i - median(X_i)}{median(|X_i - median(X_i)|)}$$

Early fusion
Aggregation

Some examples:

- Concatenation (depth-wise, column-wise)
- Average, Median
- Maximum or Minimum
- ...

Outline

Definition

In explicit fusion, as seen previously, the combination process is manually designed and tuned.
In implicit fusion, on the opposite, the combination of the features is learned automatically.

Both explicit and implicit fusion are early fusion schemes.

The extent to which fusion can be learned automatically depends on the classifier used:

- **Simple linear classifiers** require *explicit* feature fusion.
  Neural networks fall in this category.
- **Tree-based classifiers** can leverage *unscaled*, *heterogeneous* features natively.
  They can even mix *qualitative* and *quantitative* features!