Use of Image Regions in Context-adaptive Image Classification

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the paper co-authored with Jorma Laaksonen

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Main topics

1) Context-adaptive image classification
2) Use of image regions in 1)
3) Experimental investigation of importance of central objects vs. context for image classification using 1) and 2).

Context issues

- keyword of the special session: context
- two context-related issues:

  1) Analysis of existing the architecture (since 1999) of our existing PicSOM image classification system from the viewpoint of context-adaptiveness
     - method of using image regions is not context-adaptive itself

  2) The roles of objects vs. context in image classification

Central object and context

What does “context” mean

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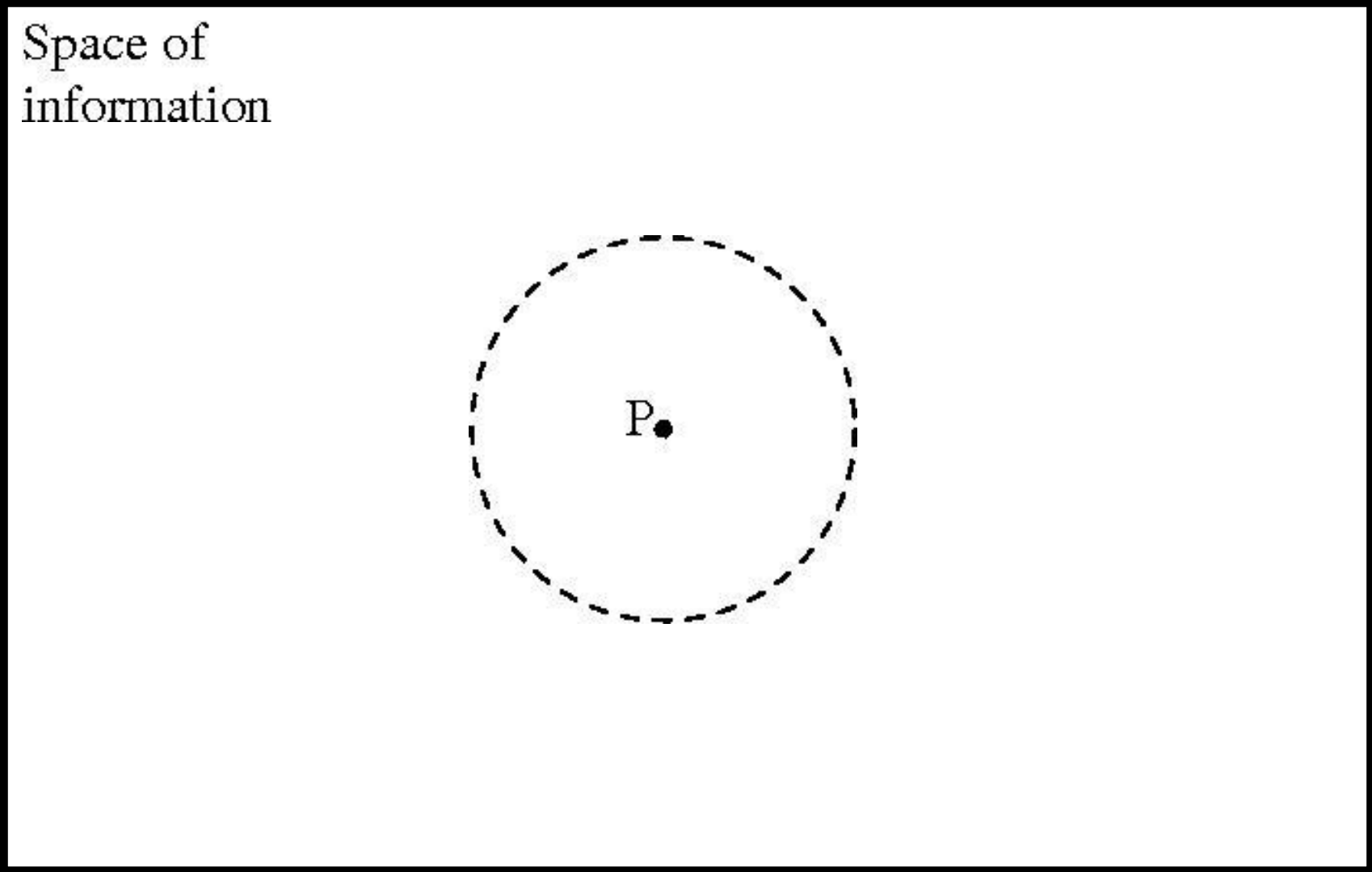
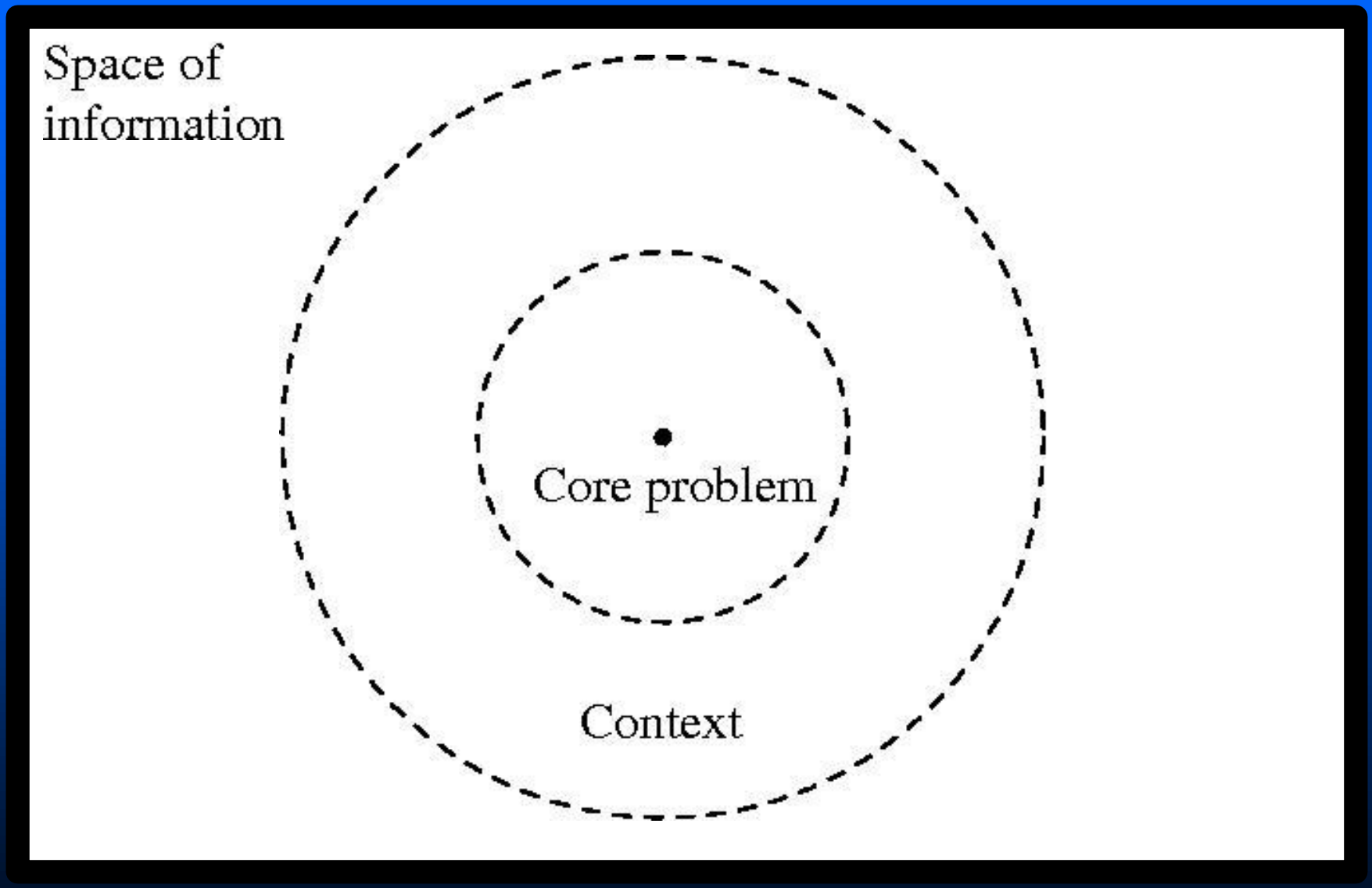


What does “context” mean



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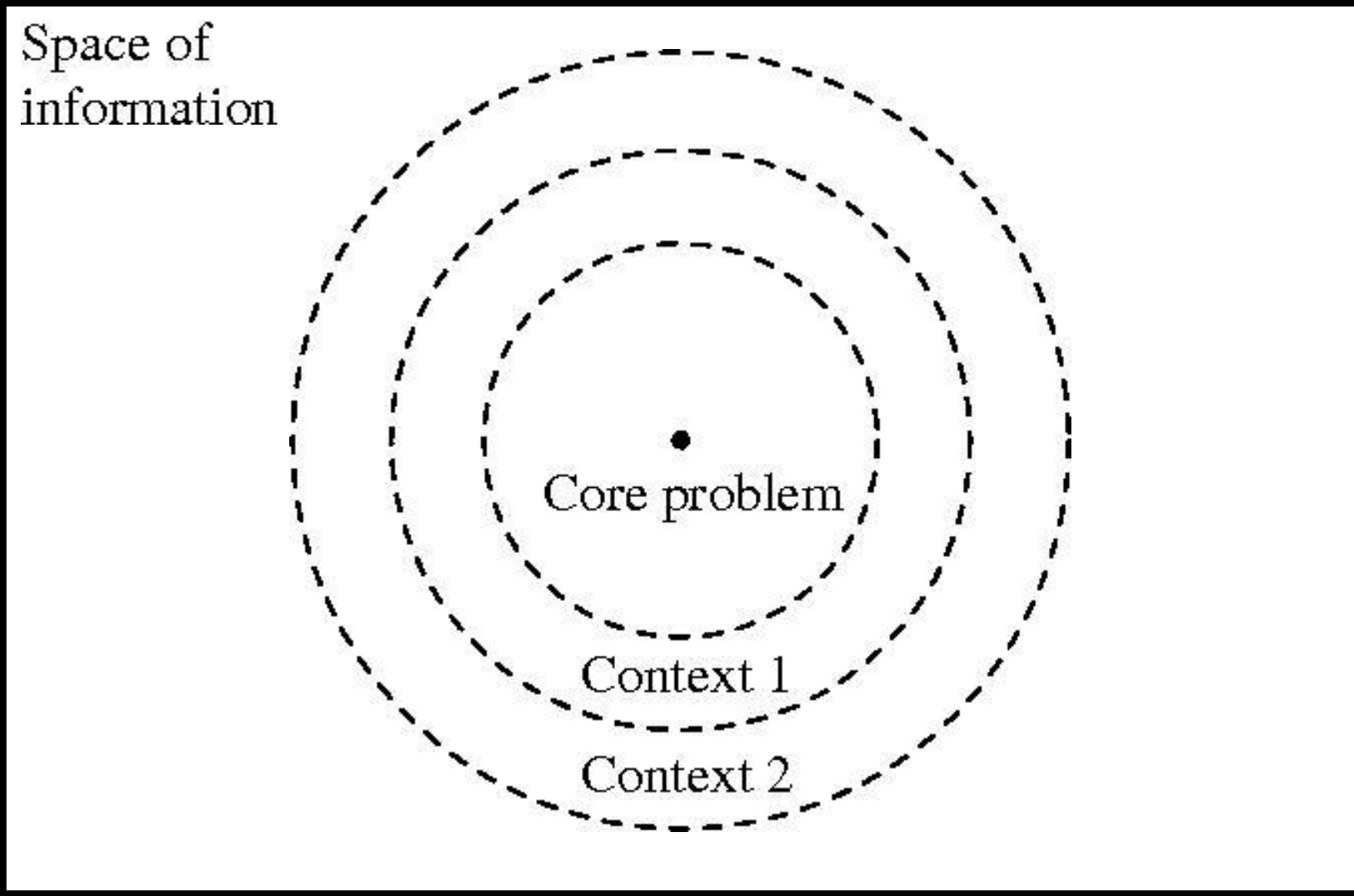
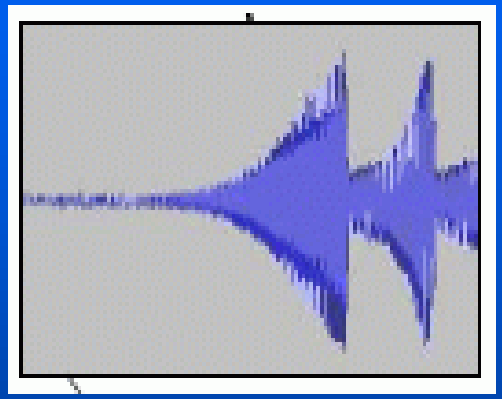
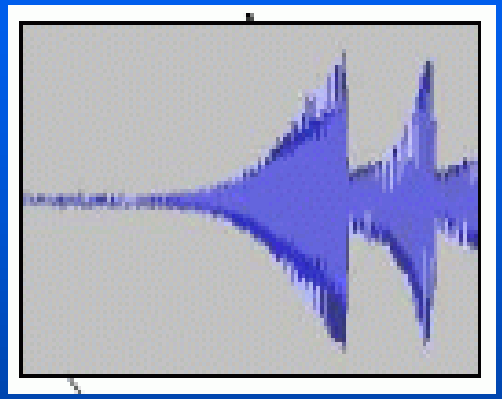


Example: speech recognition



What is this word?

Example: speech recognition

Semantic and  technologies

What is this word?

Image classification

Positive examples

Negative examples

Image classification

Positive examples

Negative examples

Is this a cow ?

Context-insensitive solution

Feature vectors

7 8 8 3 4 5

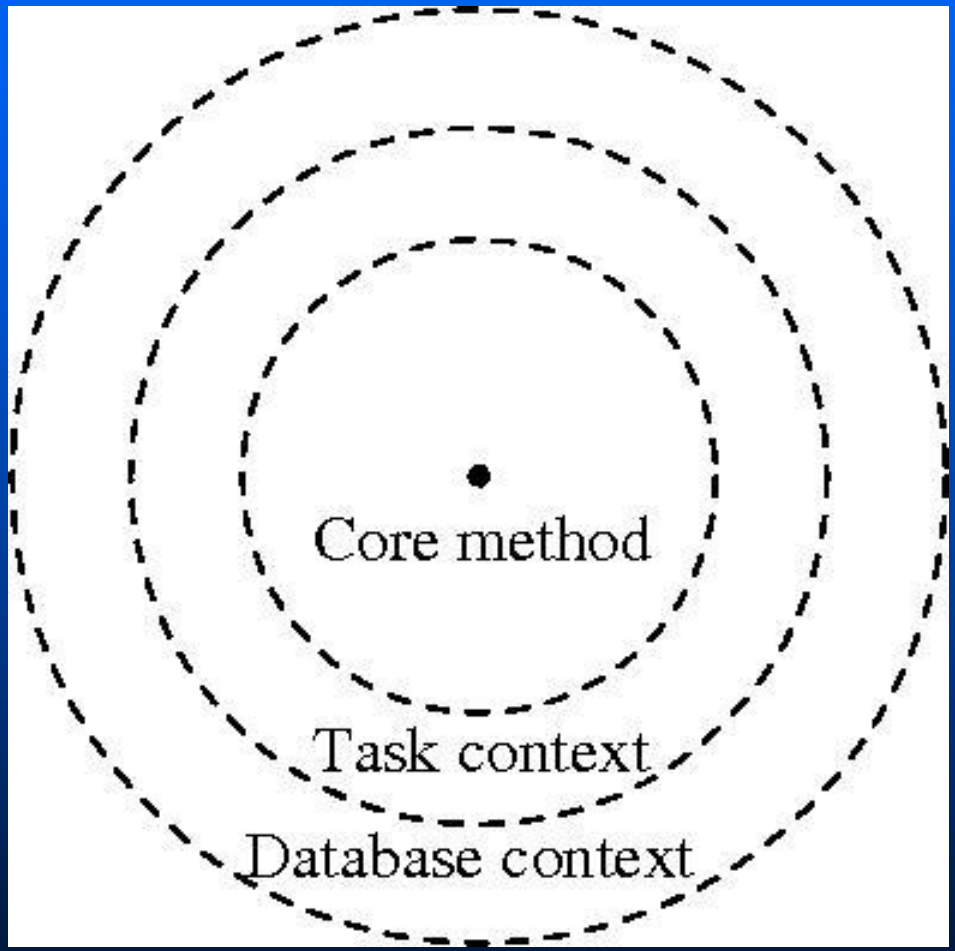
0.5 6.4 8

6 9 9 2 1

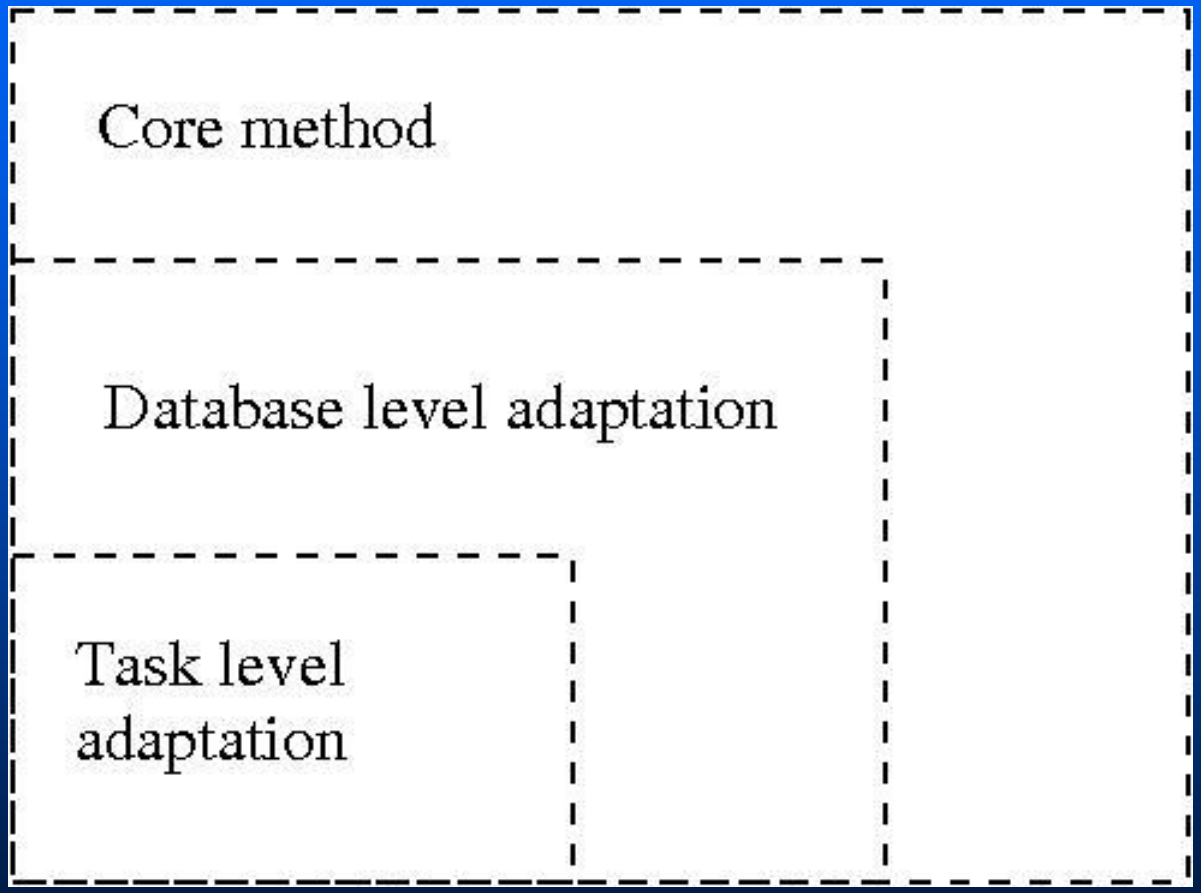
0.5 2.8 7.5

Distance calculation

Context adaptation



Context adaptation



Adaptation mechanisms

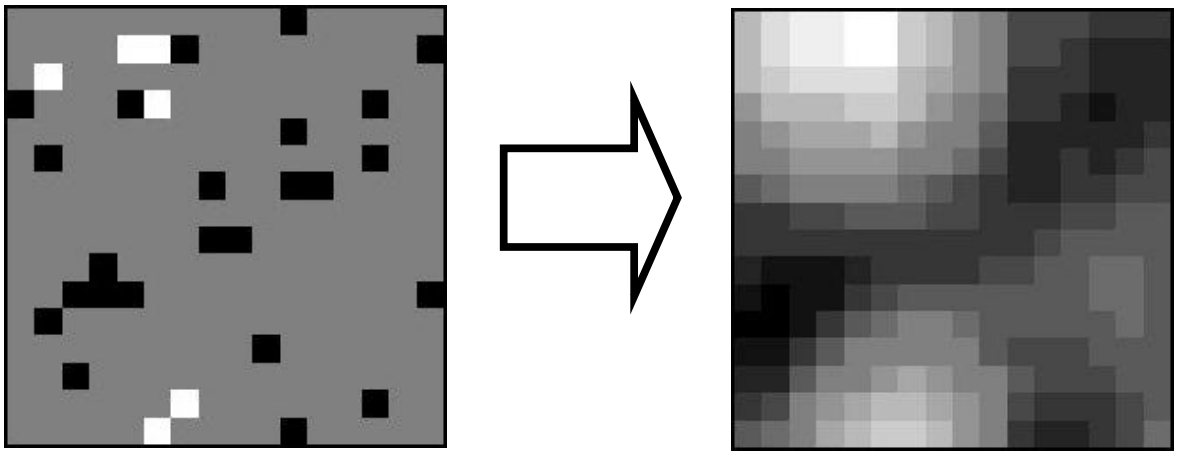
- both mechanisms operate on the feature representation and distance comparison

Database level adaptation mechanism

- represent the features in an efficient way, in that particular database
  - concentrate on feature distinctions that actually occur in the database
  - > use of a clustering method
- in particular, use a Tree-Structured Self-Organising Map (TS-SOM)
  - separate TS-SOM for each feature (colour, shape,...)

Task level adaptation mechanism

- operates on the weighting of different features in distance calculation
- end effect: features that distinguish well between example image sets get emphasised



Advantage of context-adaptation

- these adaptation mechanisms are automatic
- no human intervention for new sorts of data needed
- facilitates the use of large set of statistical visual features
  - individual feature may be statistically weak
- comes handy for example in automatic image annotation with large vocabularies

Use of image regions

- images may be segmented into regions and regions described
- how is this used to compare images?
- the same statistical spirit: fuse numerous segmentation-feature combinations
  - > need for lightweight region matching
- histograms: a simple statistical technique
  - each TS-SOM surface can be seen as histogram
  - each example image produces now several impulses
  - similarly, score for test image is not taken from single map location but several
  - effectively dot product of histograms

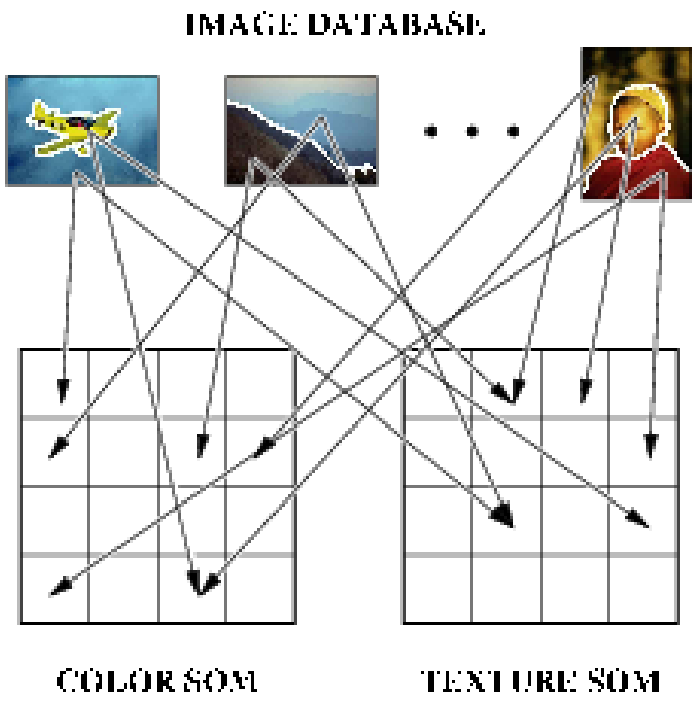


IMAGE DATABASE
COLOR SOM
TEXTURE SOM

Usefulness of segmentation

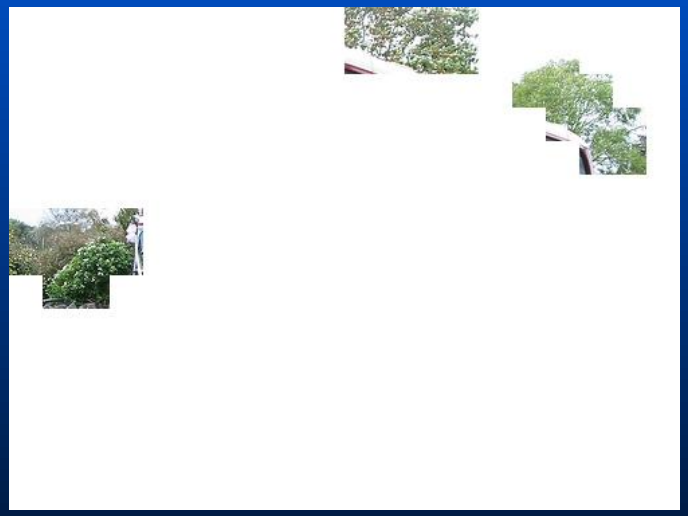
- generally, not as good as global image features
- global+segment combination gives often best results
- VOC challenge 2006 image collection: ~ 5000 natural images, 10 classes: bicycle, bus, car, cat, cow, dog, horse, motorbike, person, sheep
  - in most of the classes segments brought extra information

Central object vs. context in classification

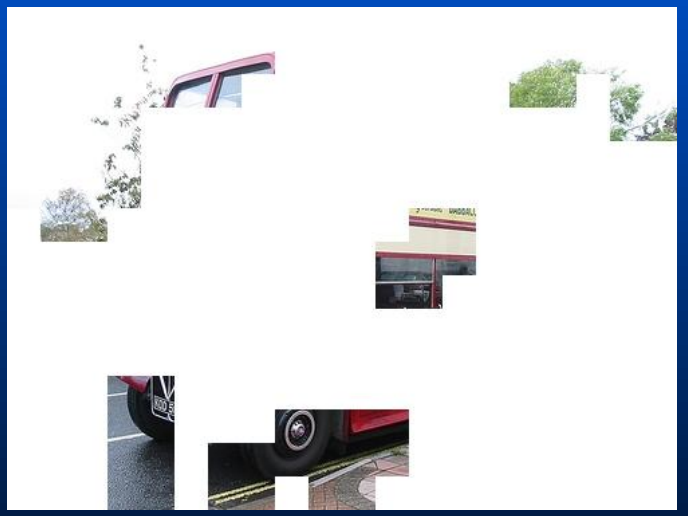
- classification results traced back to individual regions
- which regions contributed most to the classification?
- qualitative experiment with 10% of the VOC database
- images divided into regions with a fixed grid, ~140 regions/image
- top 10% regions highlighted that contributed most to the classification
  - class specific

Original

“bus”



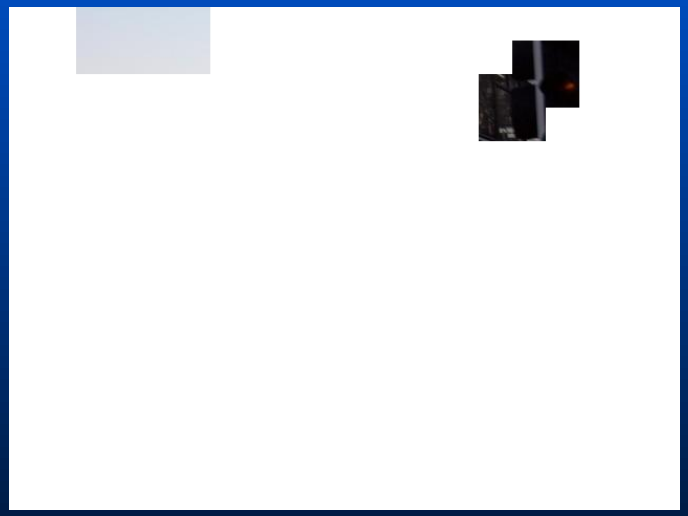
“cow”



“motorbike”

Original

“bus”



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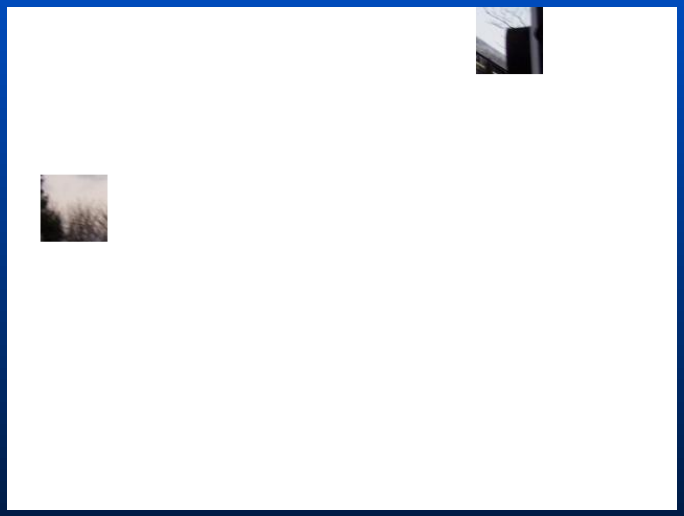

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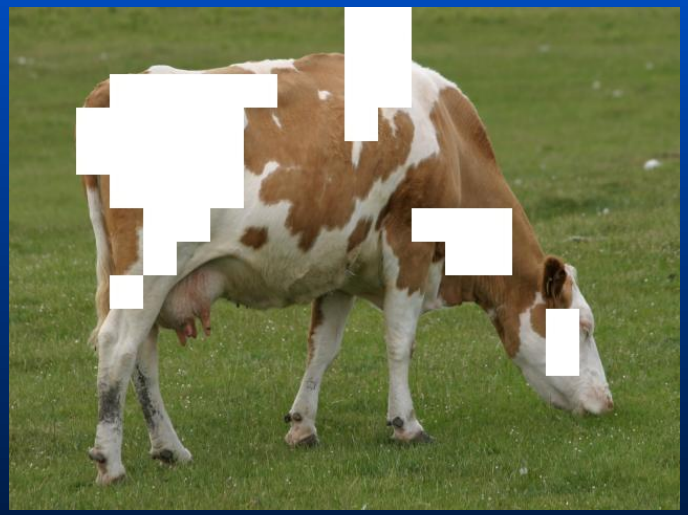

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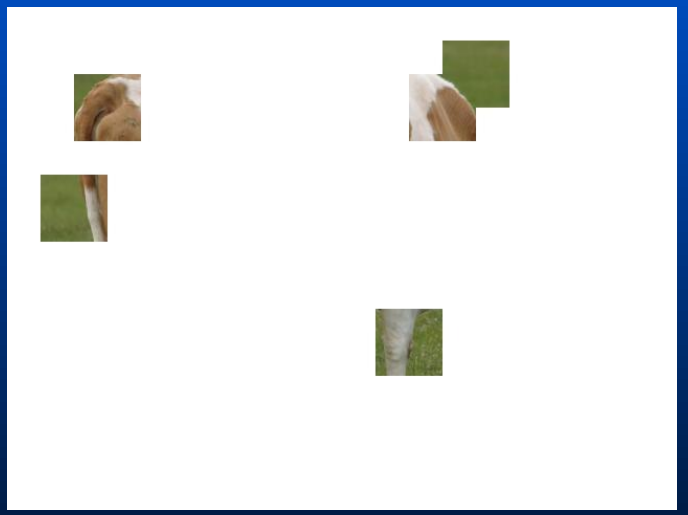

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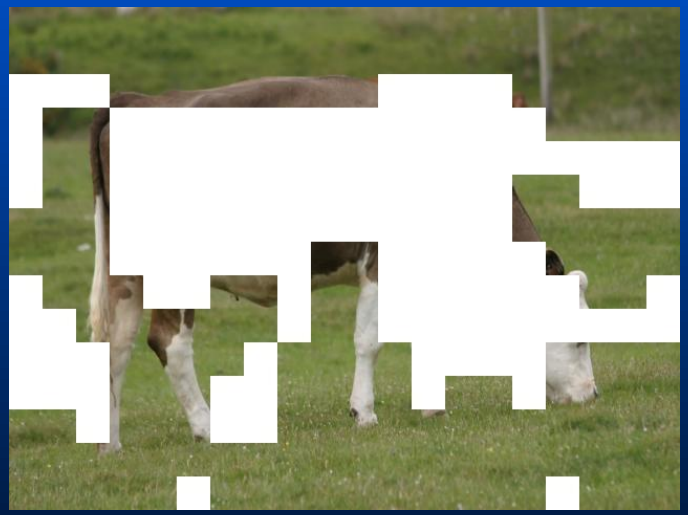

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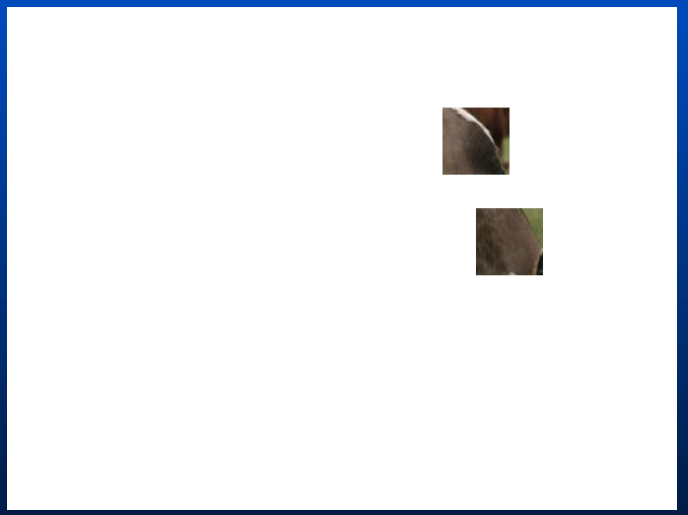

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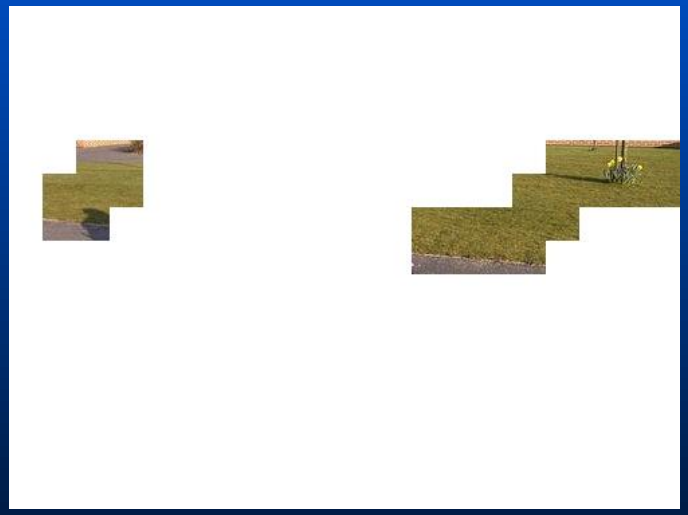

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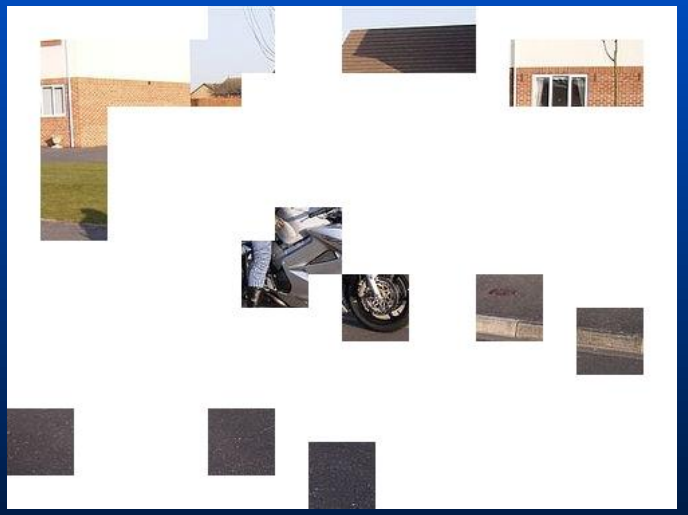

“motorbike”

AIRBUS direct

MARINE CORPS RESERVE
TOYS FOR TOTS

15
TOWER HILL

159
Marble Arch
ARRIVA

Observations

- the algorithm is
  - class specific
  - identifies sensible regions as ROIs
- important regions include both objects and context
- not all of the object is discriminative, e.g. the second cow
  - partly due to small and narrow domain database

Conclusions

- context-adaptive approach automates adaptation to novel data collections and facilitates the efficient use of statistical methods
- we described a method for identifying ROIs that adapts to the current classification task
  - does not directly lead to image segmentation method, but may provide a valuable cue
- contextual information is important for visual object detection

Questions ?

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