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Madhavan Mukund

https://www.cmi.ac.in/~madhavan

Data Mining and Machine Learning
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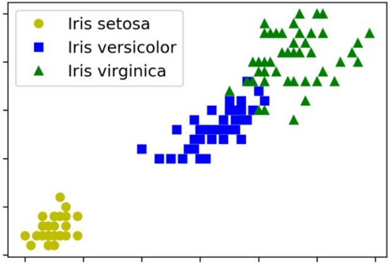
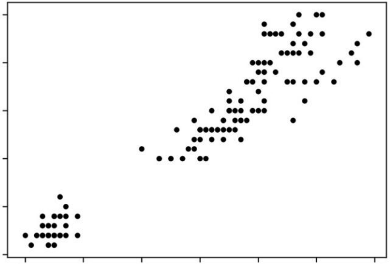
Unsupervised learning

- Supervised learning requires labelled data
- Vast majority of data is unlabelled
- What insights can you get with unlabelled data?

“If intelligence was a cake, unsupervised learning would be the cake, supervised learning would be the icing on the cake . . . ”

– Yann LeCun
ACM Turing Award 2018



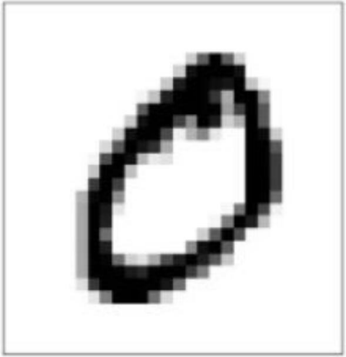


Applications

- Customer segmentation
  - Marketing campaigns
- Anomaly detection
  - Outliers
- Semi-supervised learning
  - Propagate limited labels
- Image segmentation
  - Object detection

Clustering for supervised learning

- Labelling training data is a bottleneck of supervised learning
- Handwritten digits 0,1,. . . ,9
  - 1797 images
  - 8×8 pixels, grayscale
  - Each image is a 64-tuple $(x_1, x_2, \ldots, x_{64})$



Clustering for supervised learning

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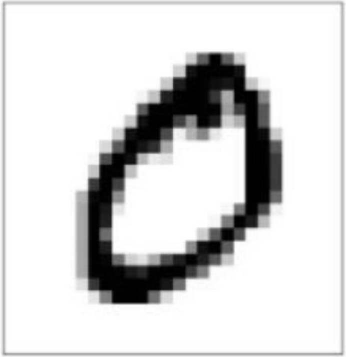
  - Each image is a 64-tuple $(x_1, x_2, \ldots, x_{64})$
- Standard logistic regression model has 97.3% accuracy

Clustering as preprocessing

- Use K Means to make 50 clusters
- Replace each input by its distance from the 50 centroids
  - Instead of $(x_1, x_2, \ldots, x_{64})$
  - $\ldots (d_1, d_2, \ldots, d_{50})$
- Logistic regression on this representation has 97.1% accuracy, a bit less than the original logistic regression!
- Varying the number of clusters changes the accuracy
  - With 88 clusters, we get 98.2% accuracy

Semi-supervised learning

- 1797 images of handwritten digits 0,1,. . . ,9
- Standard logistic regression model has 97.3% accuracy
- What if we couldn't label the entire training set?

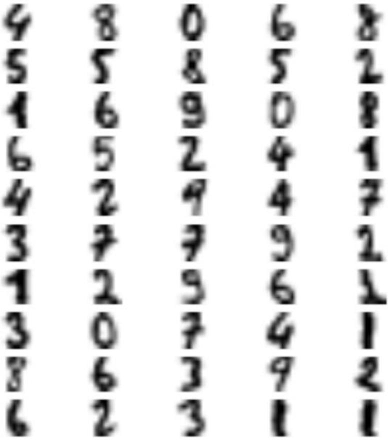


Semi-supervised learning

- 1797 images of handwritten digits 0,1,. . . ,9
- Standard logistic regression model has 97.3% accuracy
- What if we couldn't label the entire training set?
- Suppose we take 50 random samples as training set
- Logistic regression gives 82.7% accuracy

Semi-supervised learning

- Instead of 50 random samples, 50 clusters using K means
- Use image nearest to each centroid as training set
- 50 representative images
  - . . . but not randomly chosen 50
- Logistic regression accuracy jumps to 92.9%



Semi-supervised learning

- Propagate representative image label to entire cluster
- Logistic regression improves to 93.8%
- Propagate represententive image label to 25% items closest to centroid
- Logistic regression improves to 94.2%
- Only 50 actual labels used, about 5 per class!

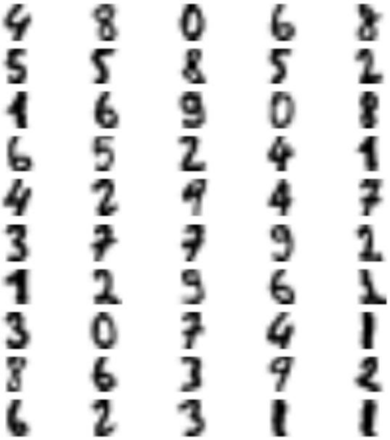
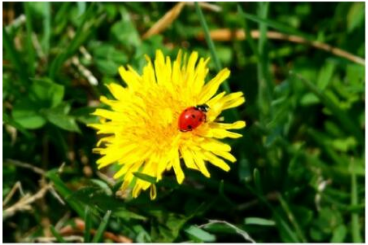


Image segmentation

- An image is a matrix of pixels
- Each pixel's colour is a triple (R,G,B)
- K means clustering on these values merges colours



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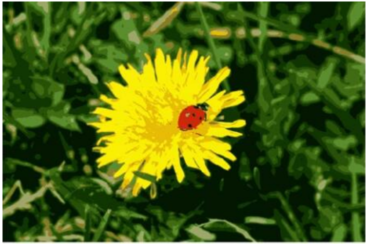
- With 10 clusters, not much change



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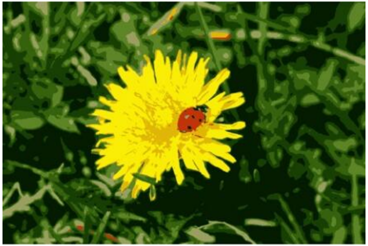
- With 10 clusters, not much change
- Same with 8



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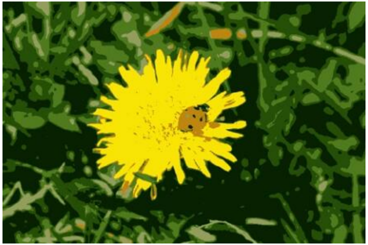
- At 6 colours, ladybug red goes



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- At 6 colours, ladybug red goes
- 4 colours

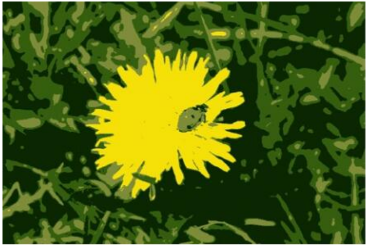

Image segmentation

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- Same with 8
- At 6 colours, ladybug red goes
- 4 colours
- Finally 2 colours, flower and rest