Texture classification using Local Binary Patterns

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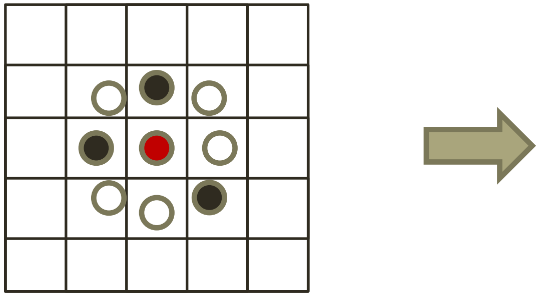
Local Binary Patterns

- A way to train a neural network to recognise textures
- Instead of using the image intensity values, measure the difference between a pixel and each of its P neighbours
- If the difference is positive, encode as 1, else 0



10010010

- Consider 10010010 the same as 00100101 (rotation invariant)

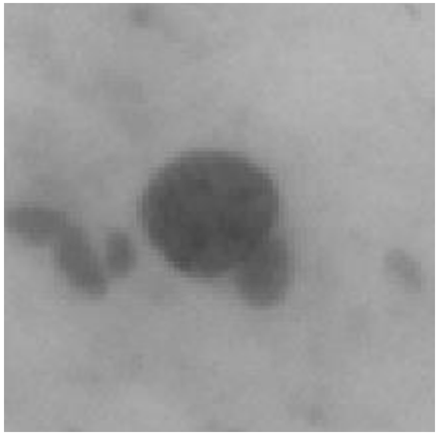
Ojala, T., Pietikainen, M. and Maenpaa, T., 2002. Multiresolution gray-scale and rotation invariant texture classification with local binary patterns. IEEE Transactions on pattern analysis and machine intelligence, 24(7), pp.971-987.

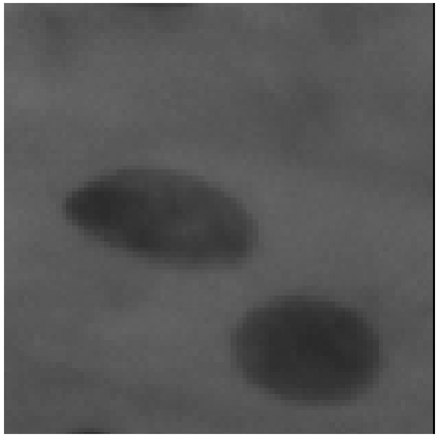
Supervised learning with LBPs

- Use the histogram of the patterns found in an image as a feature set to train a neural network
- Vary the radius (scale) to suit the resolution of the source images, and/or concatenate histograms derived from multiple scales
- Combine less common patterns to reduce noise

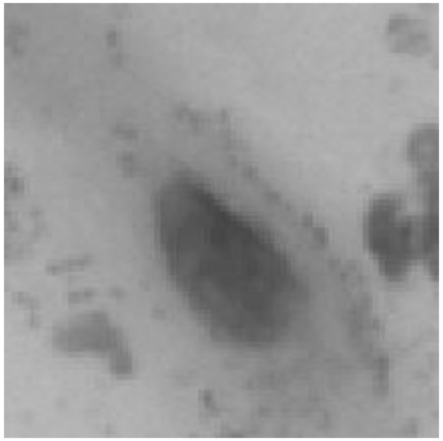
Oral cancer data

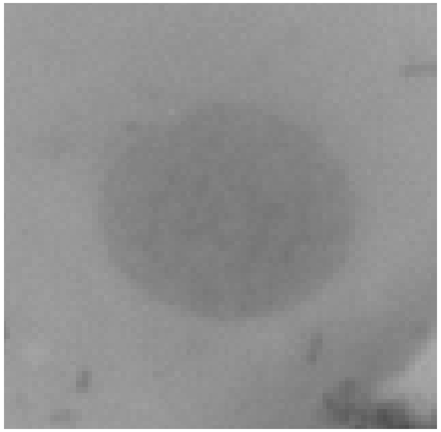
Healthy cells





Cancerous cells



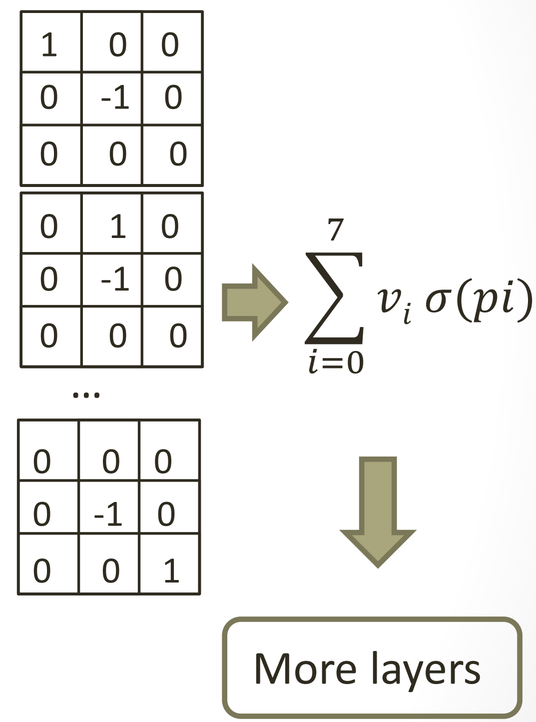


Limitations of LBPs

- The LBP histograms do not contain enough information to classify our images accurately
- Positional data (where in the image a pattern was located, which other patterns are neighbouring) is not retained
- In our case significant parts of the image are not of interest and the signal from these may overwhelm the real signal
- Noise in images affects the patterns
- Strength of pattern is not known: signal from pixels with intensity 0 & 255 same as with 127 & 128

Methods inspired by LBPs

- One related approach is to use a set of fixed filters in a CNN, where the central pixel has weight -1 and one other pixel has weight 1
- A linear combination of these filters, activated with a step function, is conceptually similar to LBPs, but retains positional information, allowing later layers to find combinations of patterns
- Juefei-Xu et al developed *local binary convolutional neural networks* which allow more general filters, with randomly placed +1s and -1s



Juefei-Xu, F., Boddeti, V.N. and Savvides, M., 2017, July. Local binary convolutional neural networks. In Computer Vision and Pattern Recognition (CVPR), 2017 IEEE Conference on (Vol. 1). IEEE.

Other methods

- Marcos, D., Volpi, M., Komodakis, N. and Tuia, D., 2017, June. Rotation Equivariant Vector Field Networks. In *ICCV*(pp. 5058-5067).
    - Uses rotated filters with tied weights (not LBPs)

- Li, L., Feng, X., Xia, Z., Jiang, X., Hadid, A.: Face spoofing detection with local binary pattern network. *Journal of Visual Communication and Image Representation* 54, 182–192 (2018)
    - Swaps histogram of pattern indices for histogram of sum of outputs of sigmoid activations (not binary)

Results

- Work in progress!
- Using pure LBPs we find that a radius of 10 pixels gives the greatest signal
- This is much greater than the filter sizes generally used in the LBP methods we have looked at (3x3)
- To do:
  - Combine histograms for two or three different scales
  - Combine LBP data with other features