**Two pass algorithm for detecting connected component:**

It almost the same algorithm that we discussed in the class. Instead of the backtracking we perform a second pass through the image to update the image. We keep equivalence list of all the component. For example if we see north and west corner of any pixel have different value. Then we keep both the number in the equivalence list. During the second pass we update each pixel by taking the value from equivalence list. [1]

**Applications**

Connected component can be an important preprocessing tool for medical image analysis. In this paper the author uses mammography image (X-ray of breast) to detect cancer. At the early stage of breast cancer, the symptoms in the image have very low contrast. So, in order to find the proper threshold(to convert grayscale image to binary image) an exhaustive search is required. To remove this drawback the author came up with an algorithm that works on the grayscale image. This algorithm based on the contour tracing.[2]

In this paper the author proposed a way of writer identification using connected-component contour. Here they used example writing form 100 different writer. Each writer is considered as a pattern generator where they produce connected components for uppercase character set by their writing. Their method got some good result. Because writing style is determined by allographic shape variations. And connected component-based contours and edge detection system works great to detect those variations. [3]

I think in above two example if we use Convolutional Neural Network (CNN) it will have better result than the connected component approach. But to train the CNN we would need a huge number of training example and hardware resources(GPU). These are the main drawback of CNN approach. And sometimes this drawback is more than enough to not using the CNN.

Ref:

[1] https://en.wikipedia.org/wiki/Connected-component\_labeling

[2] Yapa, R. D., & Koichi, H. (2007). A connected component labeling algorithm for grayscale images and application of the algorithm on mammograms. Proceedings of the 2007 ACM Symposium on Applied Computing - SAC ’07. the 2007 ACM symposium. <https://doi.org/10.1145/1244002.1244040>

[3] L. Schomaker and M. Bulacu, "Automatic writer identification using connected-component contours and edge-based features of uppercase Western script," in IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 26, no. 6, pp. 787-798, June 2004, doi: 10.1109/TPAMI.2004.18.