

A Non-Iterative Field Based Vector Quantization Algorithm

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Abstract

This article describes a new and innovative algorithm for quantizing vectors in a two dimensional space in a non-iterative way. Additionally, this technique produces an optimal number of quantized vectors, and hence, the knowledge of the number of quantized vectors is not needed beforehand.

1 Generation of clusters of vectors

Clusters of vectors have to be generated in order to test our algorithm. The clusters are generated using Fachada, N., Figueiredo, M.A.T., Lopes, V.V., Martins, R.C., Rosa, A.C., Spectrometric differentiation of yeast strains using minimum volume increase and minimum direction change clustering criteria, Pattern Recognition Letters, vol. 45, pp. 55-61 (2014), doi: <http://dx.doi.org/10.1016/j.patrec.2014.03.008> for generating 2D clusters of vectors

2 Clustering or quantizing technique

The quantizing is done across many steps. The first one is the position matrix generation.

2.1 Position Matrix Generation

In this stage, the position matrix is generated from a list of vectors. The position matrix represents a space along the positive X-axis and positive Y-axis. In this space, a point is given the value one if that set of coordinates matches one of the given vectors. If not, it has a value 0.

Therefore, the position matrix is a binary matrix.

2.2 Field Matrix Generation

The field matrix is a very important matrix. Usually, it has far lesser number of rows and columns than the position matrix.

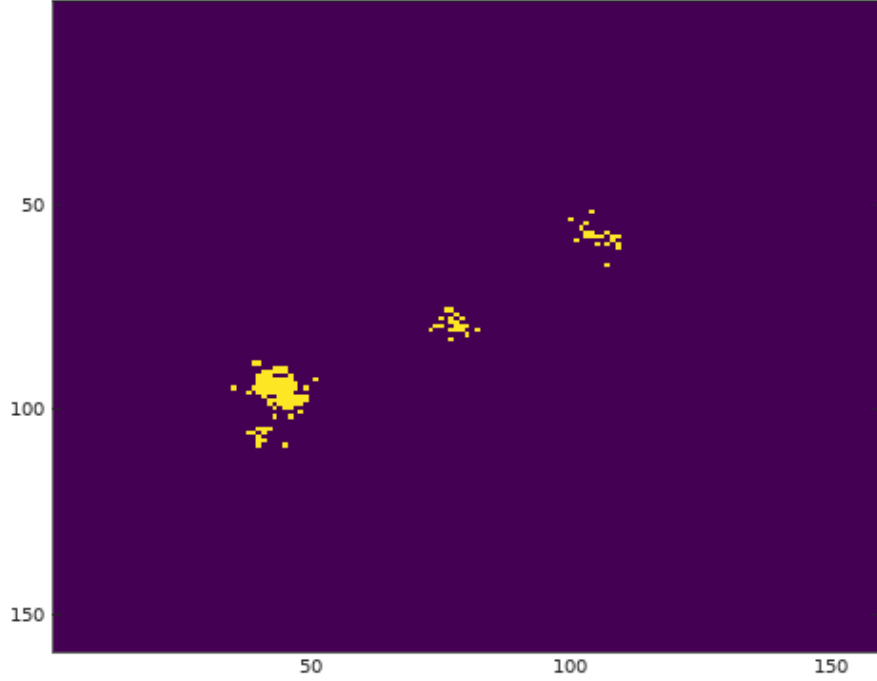


Figure 1: A position matrix's graphical representation. This matrix has 159 rows and 159 columns.

The field matrix is initialised with a maximum value at its center. All points around the threshold have a value lower than the center proportional to the point's distance from the center.

The values reduce till a fixed lower limit is reached. The matrix terminates at this lower bound.

It is important to note that the field can reduce as any positive power of the distance. For high resolution quantization, this power that is chosen can be high, while lower powers can be chosen for lower resolution quantization.

2.3 Superfield Matrix Generation

The superfield matrix is the matrix that represents the combined fields generated by each point in the position matrix. This matrix is initialised as a zero matrix with the same dimensions as the position matrix. Here, the field matrix is added around each point where the position matrix has a value 1. Therefore, a field exists around wherever the position matrix has a 1.

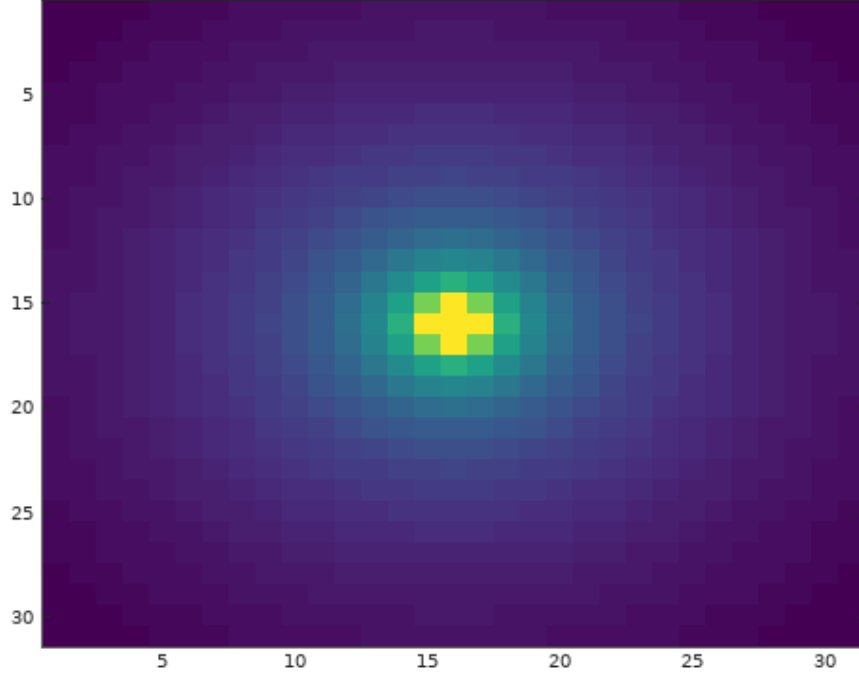


Figure 2: A field matrix's graphical representation. This matrix has 31 rows and 31 columns. It has a center value of 1000.

2.4 Quantization from the Superfield Matrix

The quantized vectors are found from the superfield matrix by simply finding the local maximas in the matrix. The local maximas represent the quantized vectors.

3 The Program

This is the program used to perform all the calculations and obtain the time-frequency data

```
%VQ2D is a vector quantization algorithm for two-dimensional vectors implemented
%field quantization technique
%Using Fachada, N., Figueiredo, M.A.T., Lopes, V.V., Martins, R.C., Rosa, A.C.,
%for generating 2D clusters of vectors
[data cp idx] = generateData(1, 0.5, 5, 15, 15, 5, 1, 2, 200);
%data = [];
%for i = 1:5:100
% for j = 1:5:100
```

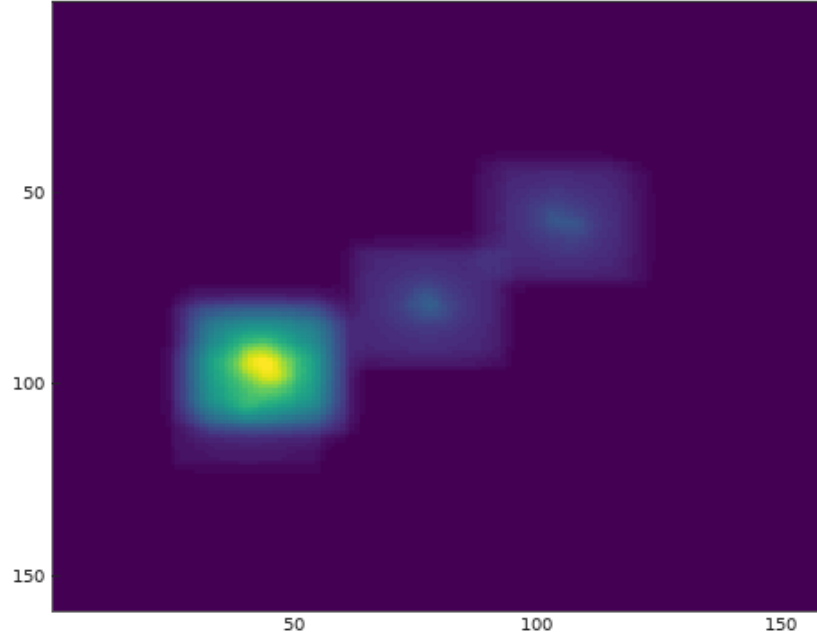


Figure 3: Superfield matrix's graphical representation. This matrix has the same dimensions as the position matrix

```
%      data = [data ; i j];
%      end
%end

data = data - min(min(data)) + 35;
data = round(data);
centerval = 1000;
%plot(data(:,1),data(:,2), 'r');

%Clusters have been generated. Now, we have to generate the subfield matrix

%Creation of subfield matrix
matsize = 31;
fieldmat = zeros(matsize,matsize);
fieldmat((matsize+1)/2,(matsize+1)/2) = centerval;%Center of fieldmat is defined
for i = 1:rows(fieldmat)
    for j = 1:columns(fieldmat)
        d = sqrt(power(i-(matsize+1)/2,2) + power(j-(matsize+1)/2,2));
        fieldmat(i,j) = centerval/(d**0.5);
    end
end
```

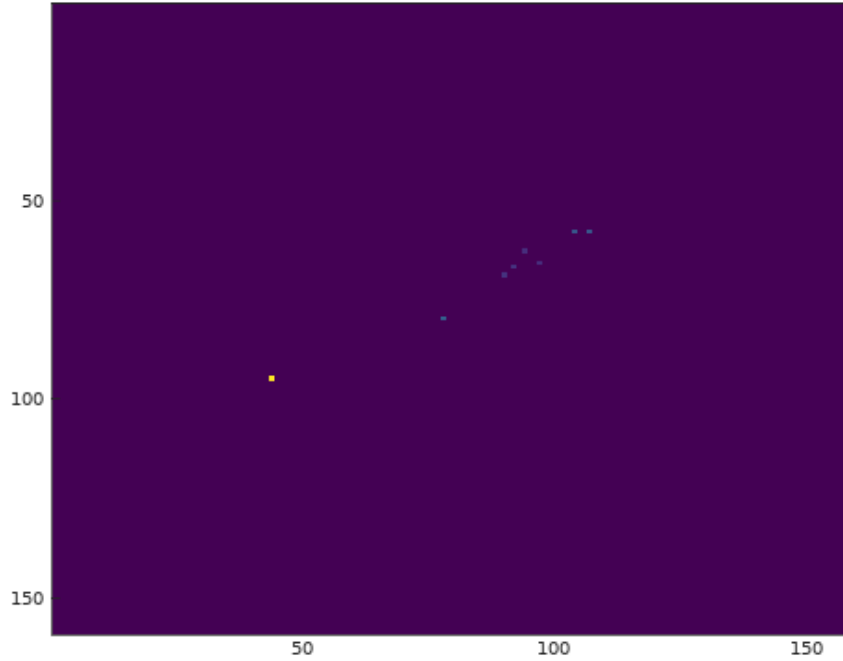


Figure 4: The spots in the image represent the position of the quantized vectors. Brighter spots represent the number of vectors that can be quantized through that point

```

end
end
fieldmat((matsize+1)/2,(matsize+1)/2) = centerval;
%Subfield matrix fieldmat has been created
%Create datamap called posmat
max_x = max(data(:,1));
max_y = max(data(:,2));
posmat = zeros(max_x + 50,max_y + 50);

for i = 1:rows(data)
    posmat(data(i,1),data(i,2)) = 1;
end

%The datamap called posmat has been created
%Proceed to apply fieldmat to all the required points
%First, create a zero field matrix of required size

```

```

superfield = zeros(rows(posmat), columns(posmat));
srows = (rows(fieldmat)-1)/2;
scols = (columns(fieldmat)-1)/2;
for i = 1:rows(superfield)
    for j = 1:columns(superfield)
        if (posmat(i,j) == 1)
            superfield(i-srows:i-srows+matsize-1,j-scols:j-scols+matsize-1) = superfie
        end
    end
end

r = rows(superfield);
c = columns(superfield);

%Find local maximas
vqmat = zeros(r,c);
for i = 2:r-1
    for j = 2:c-1
        i
        j
        fflush(stdout)
        if superfield(i,j)>superfield(i+1,j)
            if superfield(i,j)>superfield(i-1,j)
                if superfield(i,j)>superfield(i,j+1)
                    if superfield(i,j)>superfield(i,j-1)
                        vqmat(i,j) = superfield(i,j);
                    end
                end
            end
        end
    end
end
end

```

4 Advantages of this technique

- The described technique is non-iterative. Hence, it can be implemented in real time algorithms.
- The technique does not require the knowledge of the number of quantized vectors beforehand. So, the algorithm lets the user know the ideal number of vectors.
- Unlike techniques like k-means, the described algorithm produces the same set of quantized vectors on repetition. Therefore, there are no uncertainties involved.

5 Conclusion

In conclusion, this algorithm is capable of providing definitive results with good speed. No guessing from the user's side is required on the number of quantized vectors. This leads to a dependable algorithm. More work needs to be done in optimizing the algorithm to ensure satisfactory results.