An Image Processing Application on QuickCog and Matlab

"Letter Recognition"

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Overview

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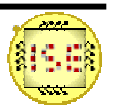


Motivation & Task

- Motivation

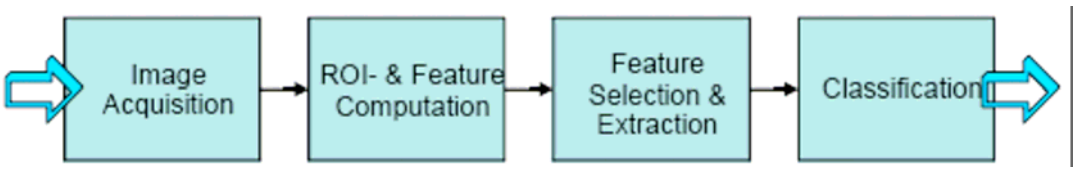
  Nowadays, the machine is used to recognize the object

  instead of person's eyes.

- Task

  My project is about one of these useful applications.

  Letter recognition by image processing using QuickCog and Feature Selection (SFFS/SFBS) in Matlab.



1. 1 Feature Selection & Extraction—Matlab

- **Reason:** Find minimum feature subset with optimum discriminance.

  For the image data, it has RGB three channel, each channel has 256 features, total features are 256*3=768. It takes too long time to compute.
- **Method:** Apply heuristics & optimization strategies to find at least a local optimum with bounded time and effort.

- We use Matlab programs.

1.2 Feature Selection & Extraction —SFS&SBS

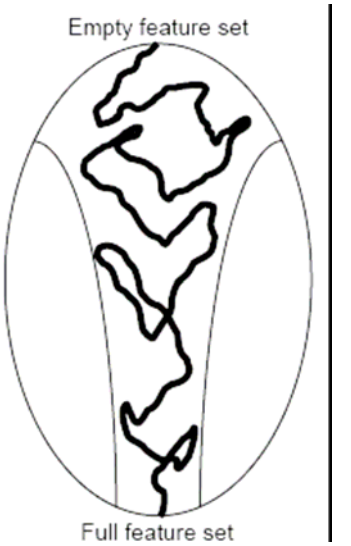
- Sequential Forward Selection

```
-  -  3  -  :   0.74300
-  -  3  4  :   0.98082
1  -  3  4  :   0.96783
1  2  3  4  :   0.95417
Best Quality: 0.98082
Best Features: 3  4
```

- Sequential Backward Selection

```
1 2 3 4 5   0.903846
- 2 3 4 5   0.942308
- - 3 4 5   0.961538
- - - 4 5   0.961538
- - - - 5   0.913462
Optimum quality: 0.961538
Significant Features: 4 5
```

1.3 Feature Selection & Extraction—SFFS&SFBS



- SFFS

  Starts from the empty set, after each forward step, SFFS performs backward steps as long as the objective function increases.

- SFBS

  Starts from the full set, after each backward step, SFFS performs forward steps as long as the objective function increases.

- The advantage compared with SFS and SBS

  Eg, 1 2 3 4 is better than 1 2 3. But 1 2 4 is better, in SFFS it lose this feature combination.

1.3 Feature Selection & Extraction—SFFS&SFBS

- SFFS

13	[10 13]	[7 10 13]	[7 10]	7	[1 7 10]
1	0.87729	0.915	0.8854	1	0.93112

- SFBS

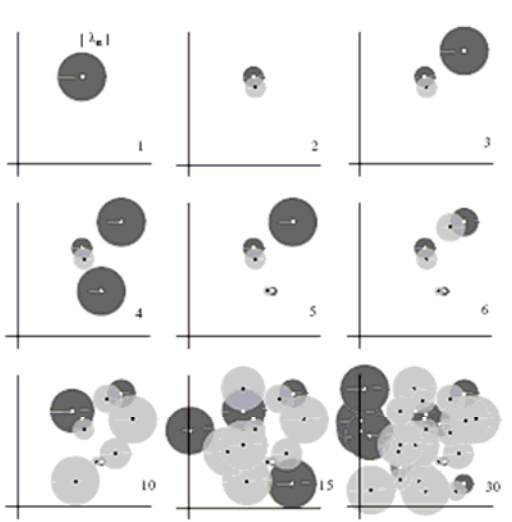
[1 2 3 4 5 6 7 8 9 10 11 12 13]	[1 2 4 5 6 7 8 9 10 11 12 13]
0.98	0.94

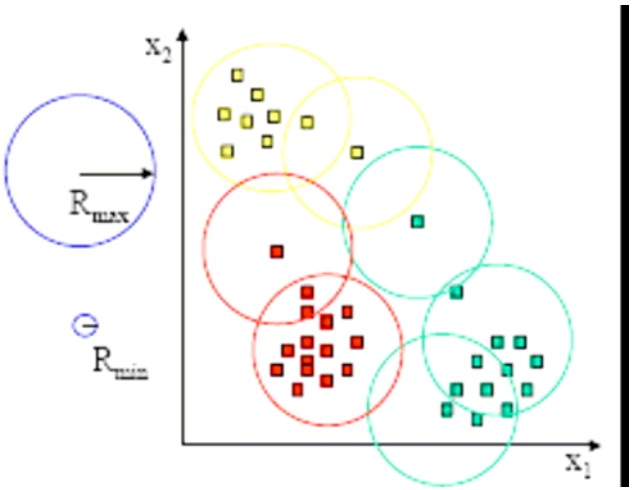
[1 2 4 5 7 8 9 10 11 12 13]	[1 2 4 5 7 8 10 11 12 13]
0.93	0.92

[1 2 4 5 6 7 8 10 11 12 13]
0.95

2. Assessment function—RCE Classification

- The assessment function is RCE classification.
- Each pattern unit has an adjustable parameter that corresponds to the radius of the d-dimensional sphere. During training, each radius is adjusted so that each pattern unit covers a region as large as possible without containing a training point from another category.





3. K-fold Cross-Validation Technique

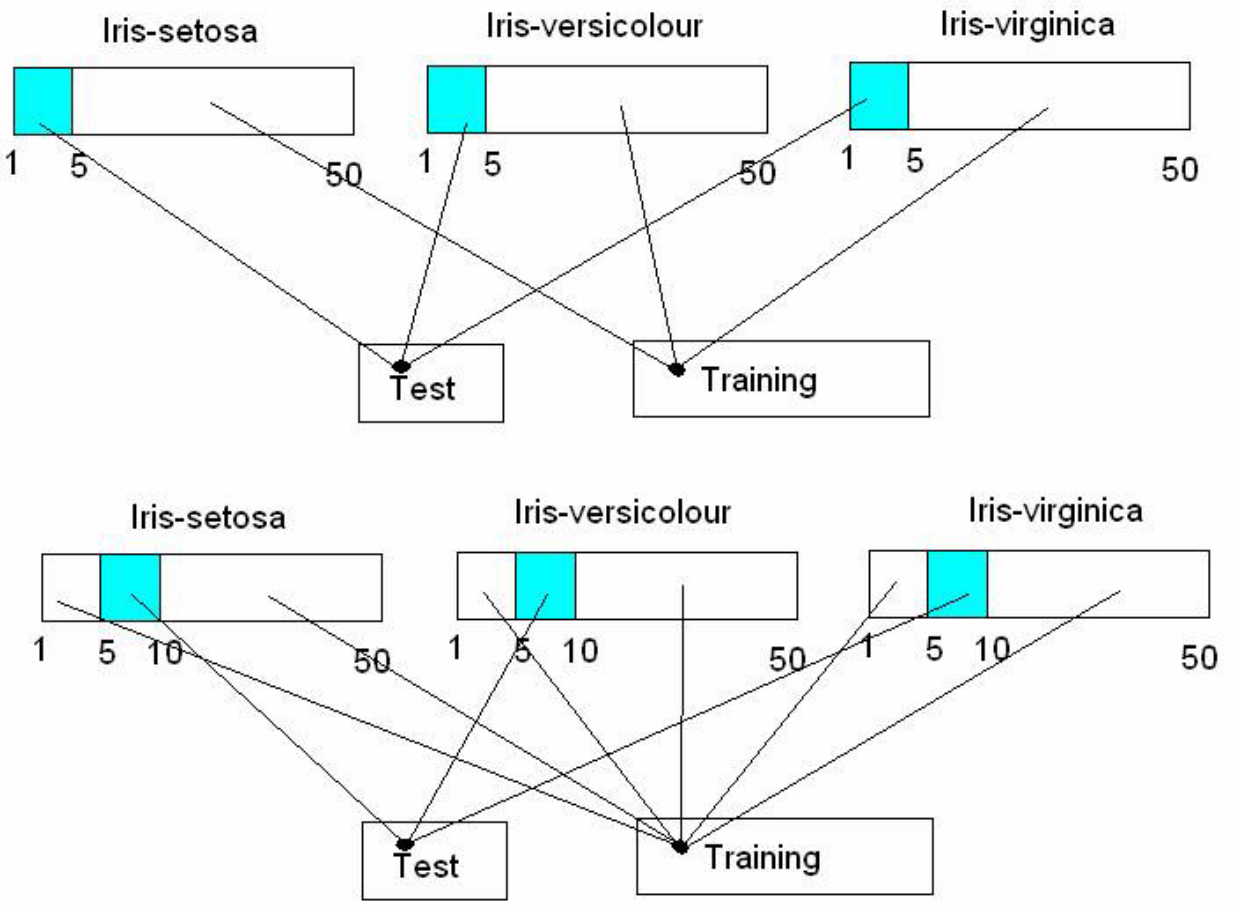
- We use the k-fold cross-validation technique for assessment of each feature Subset.

- k-fold cross-validation technique

- Advantage

  The different training and testing data will show different result, only make randem of the data is not enough.

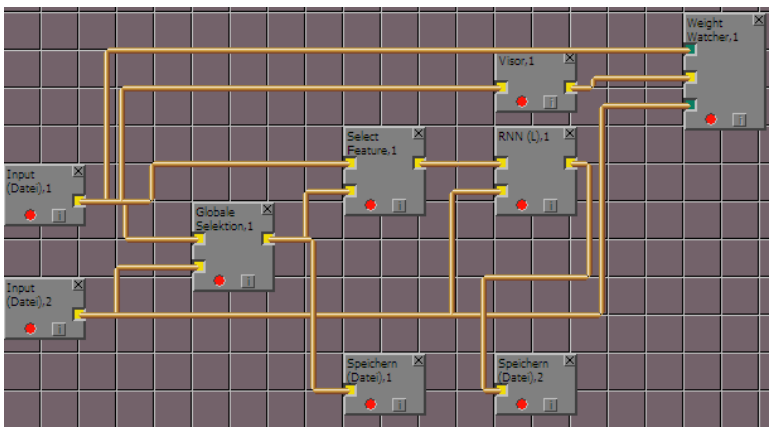
3. K-fold


Iris-setosa
Iris-versicolour
Iris-virginica
1
5
50
1
5
50
1
5
50
Test
Training
Iris-setosa
Iris-versicolour
Iris-virginica
1
5
10
50
1
5
10
50
1
5
10
50
Test
Training

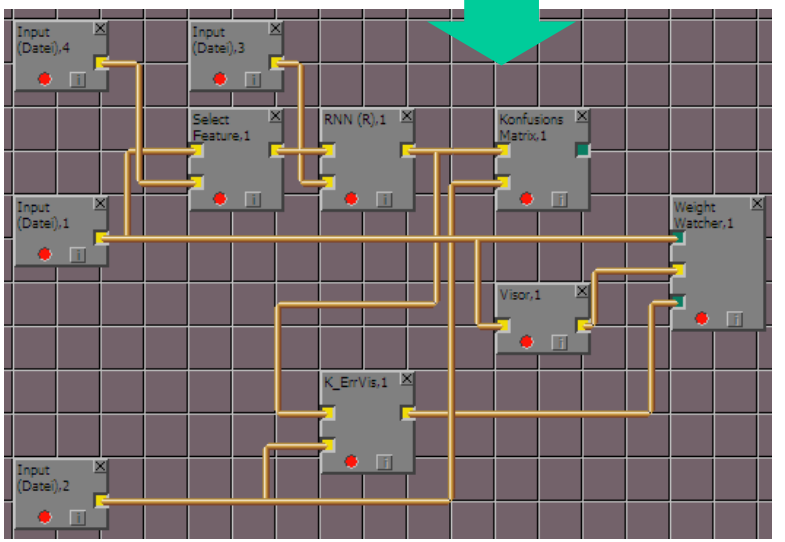
4. Check the Feature Selection—QuickCog

- We use the RNN, PNN and KNN to check whether the feature selection is good in Quickcog.

Training



Testing



5. Check Results

	Vowel	Segment
Selected Feature SFFS	1 2 3 4 5 6 7 8 9 10	2 5 8 11 14 16
Best Quality	98.08%	96.75%
Selected Feature SFBS	1 2 3 4 5 6 7 8 9 10	2 5 8 11 12 15 16
Best Quality	98.08%	95.67%
Check RNN Quality	91.72%	SFFS 95.89%, SFBS 92.56%
Check PNN Quality	80.20%	SFFS 96.97%, SFBS 88.41%
Check KNN Quality	95.96%	SFFS 96.54%, SFBS 94.85%

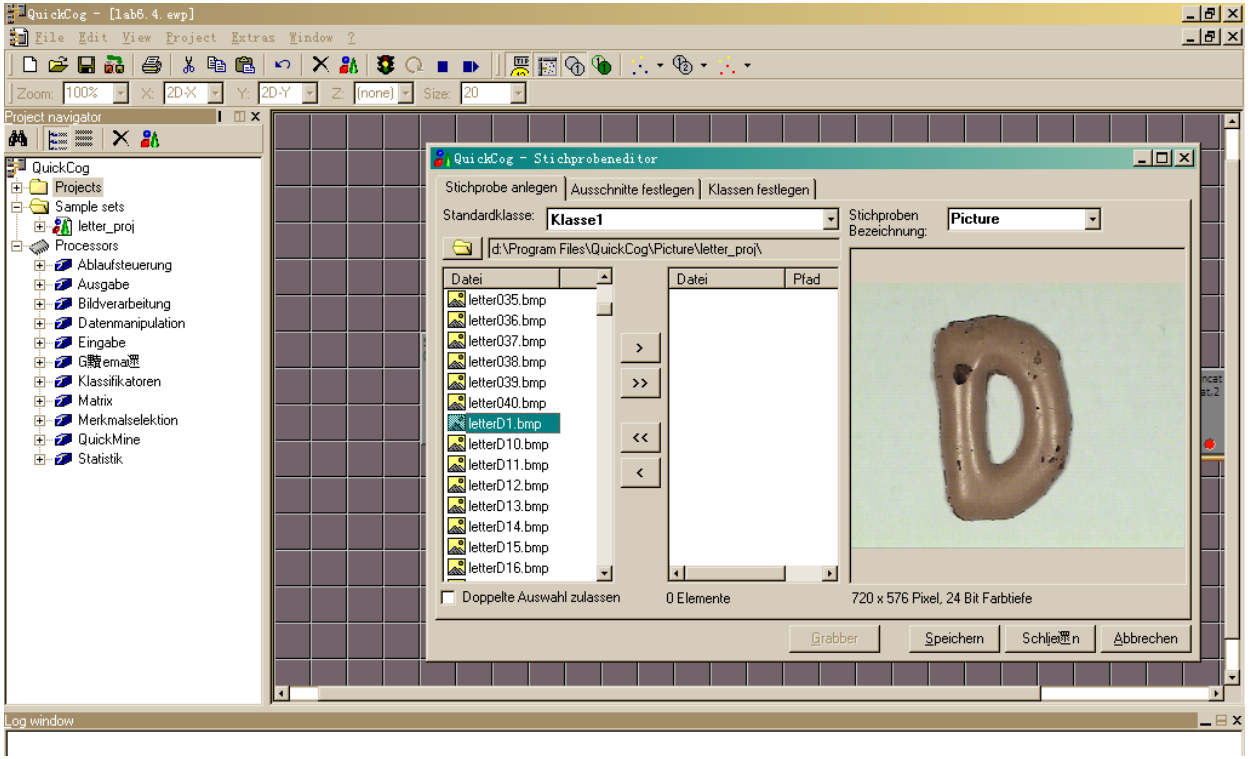
6. Letter Detection

- Now we know the feature selection and classification, we can do our project Letter Detection with the techniques above.

- We use 7 letters: D E K P R S Z

6.1 Image Acquisition—QuickCog

- Firstly, We have collected the photos of there different letters and classified them in QuickCog Stichprobeneditor.



6.1 Image Acquisition—Technique

- We must acquire sufficient samples for training and testing.
- The point during image acquisition: different position and angle.

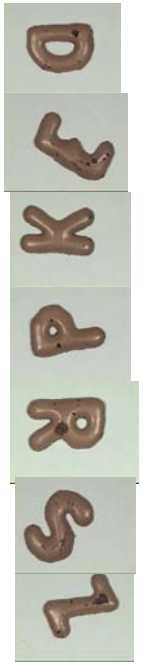
6.1 Image Acquisition—Image Selection

- Good Image

- Bad Image

6.1 Image Acquisition—Image Data

- D: 19
- E: 21
- K: 17
- P: 15
- R: 14
- S: 19
- Z: 21



- Total Samples: 126
- Class: 7.

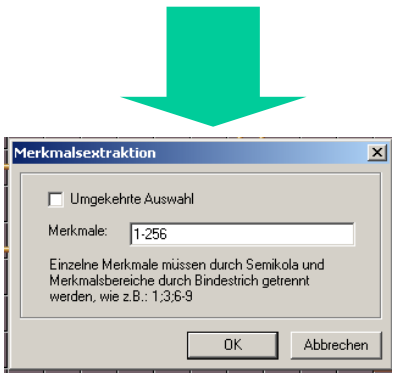
6.2 ROI & Feature Computation —QuickCog

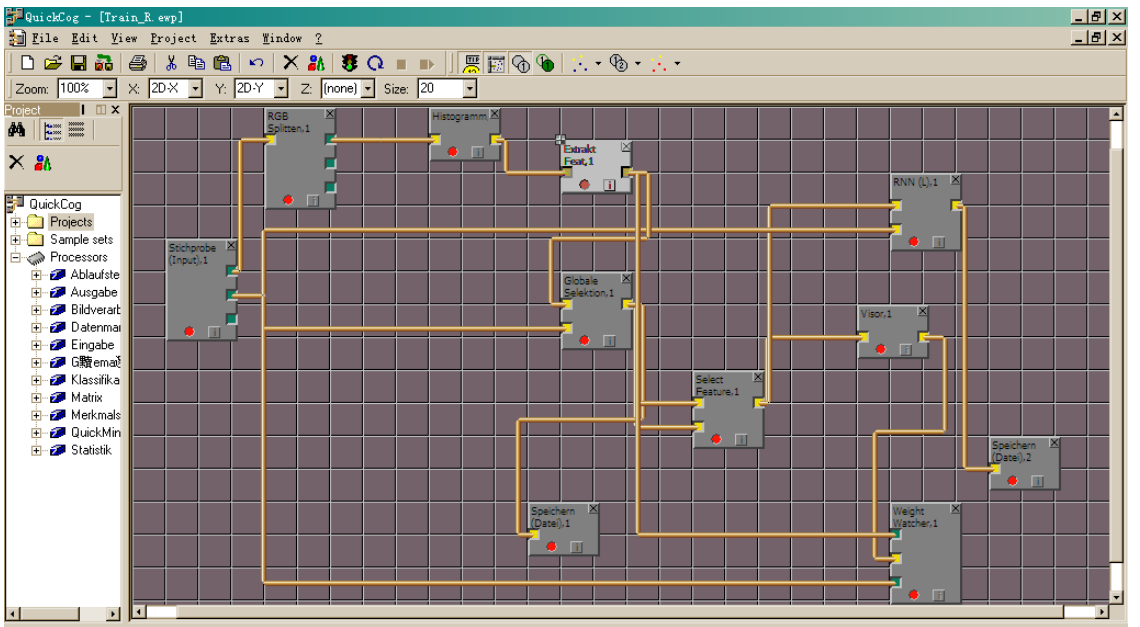
- For the data, the moment invariant and the transform don't show good result. The reason might be that there exists shade and some dirt which influence the moment invariant and the transform.

- However the histogram shows good result, as the histogram reflects the area, the dirt compare to the letter area is small. So I used the histogram feature computation.

6.2 ROI & Feature Computation —QuickCog

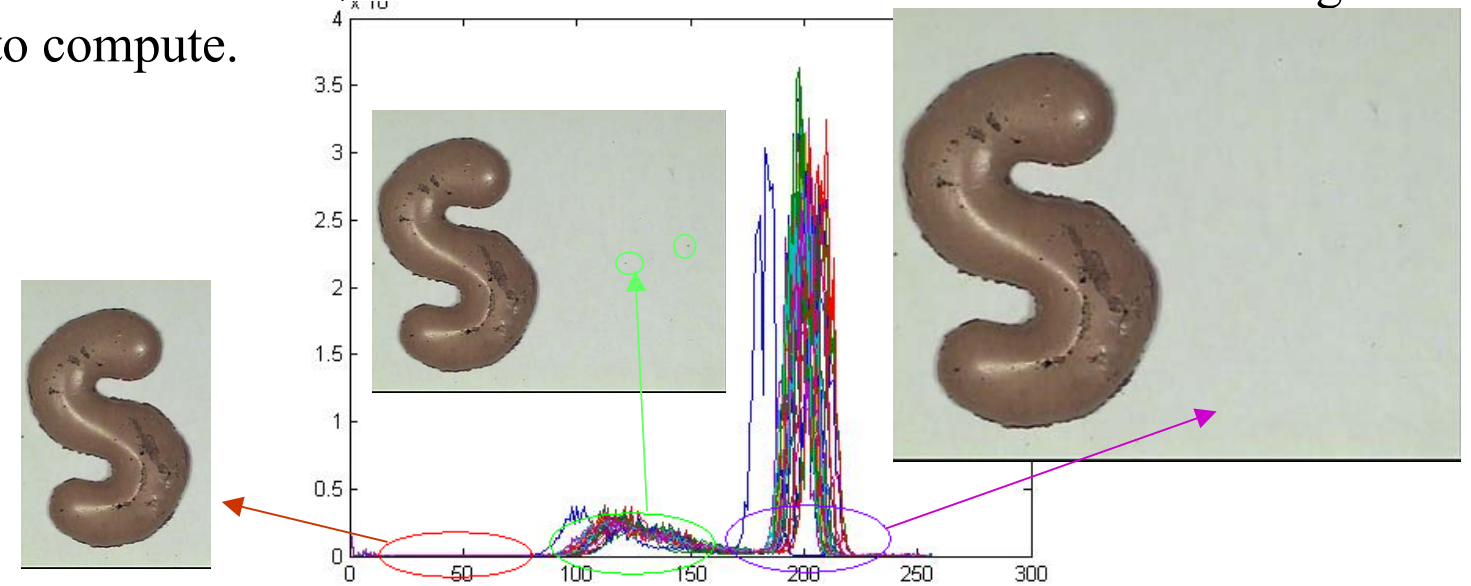
- After data aquisition, we used histogram according to three different colours (red, blue, green) in order to get some statistics about the features of the data and selected the features randomly.





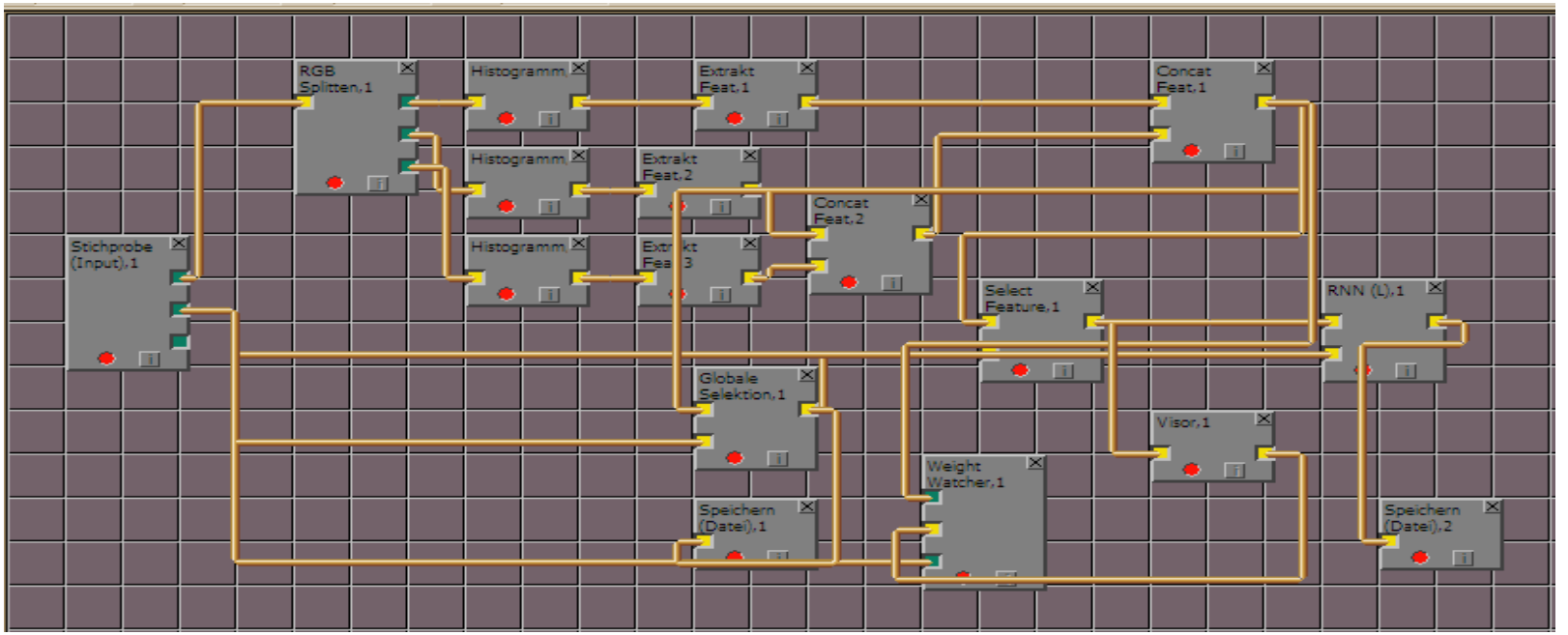
6.2 ROI & Feature Computation —QuickCog

- For the letter recognition, it has RGB three channel, each channel has 256 features, total features are 256*3=768. It takes too long time to compute.



- We select the important features from 3 channels, and then combine the 3 channel's features.

6.2 ROI & Feature Computation —QuickCog



6.2 ROI & Feature Computation —QuickCog

- R Channel: Best Quality: 0.91481
- Best Features: **1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 28 29 30 31 32 33 34 35 36 37 38 39 40 42 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80** 81 82 83 84 85 87 89 138 139 151 167 172 173 222 223 226 229 236 245 246 247 248 249 250 251 252 253 254 255 256

- G Channel: Best Quality: 0.90384
- 1 2 3 4 5 6 7 8 9 10 11 12 13 **17 18 19 20 21 22 23 24 25 26 28 29 30 31 32 33 34 36 37 38 39 40 41 42 43 45 46 47 48 49 50 52 53 54 55 56 57 58 59 60 61 62 63 64 66 67 68 69 70 71 72 73 74 75 78 79 80 81** 85 87 89 138 139 141 148 150 167 172 173 222 226 229 236 245 246 247 252 253 254 255 256

- B Channel: Best Quality: 0.90012
- 1 2 3 4 5 6 7 8 9 10 11 12 13 **17 18 19 20 21 22 23 24 28 29 31 32 33 34 36 37 38 39 41 42 43 45 46 47 48 49 50 52 53 54 55 57 59 60 61 62 63 64 66 67 68 69 70** 82 86 88 120 127 128 136 150 155 156 160 170 177 178 226 229 236 245 246 247 250 251 252 253 254 255 256

6.2 ROI & Feature Computation —QuickCog

- R Channel
- Extract Features: 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80
- G Channel
- Extract Features: 40 41 42 43 45 46 47 48 49 50 52 53 54 55 56 57 58 59 60
- B Channel
- Extract Features: 40 41 42 43 45 46 47 48 49 50 52 53 54 55 56 57 58 59 60
- Total Features ：R+G+B= 63.

6.3 Feature Selection—SFFS/SFBS in Matlab

- Now we can do SFFS/SFBS in Matlab.

- Best Feature from SFFS

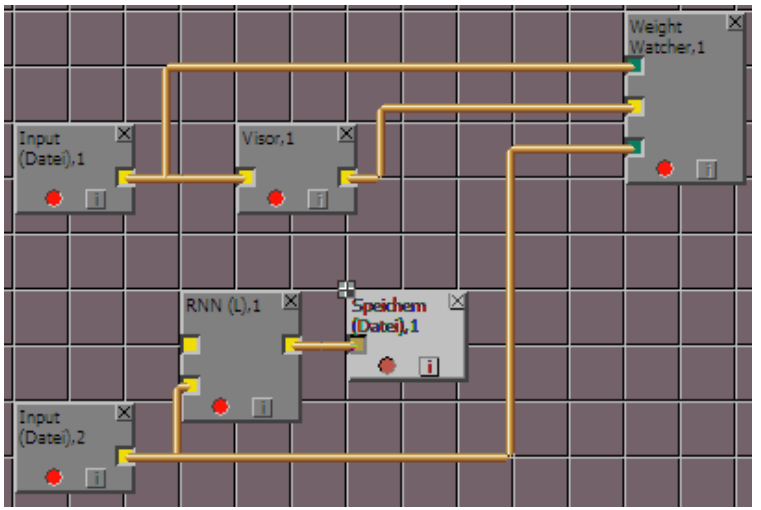
  [1 2 3 4 5 6 7 8 9 10 11 13 14 15 17 18 19 20 21 22 23 26 39 40 41 42 49 50 51 52 53 55 56 58 62];

- Best Feature from SFBS

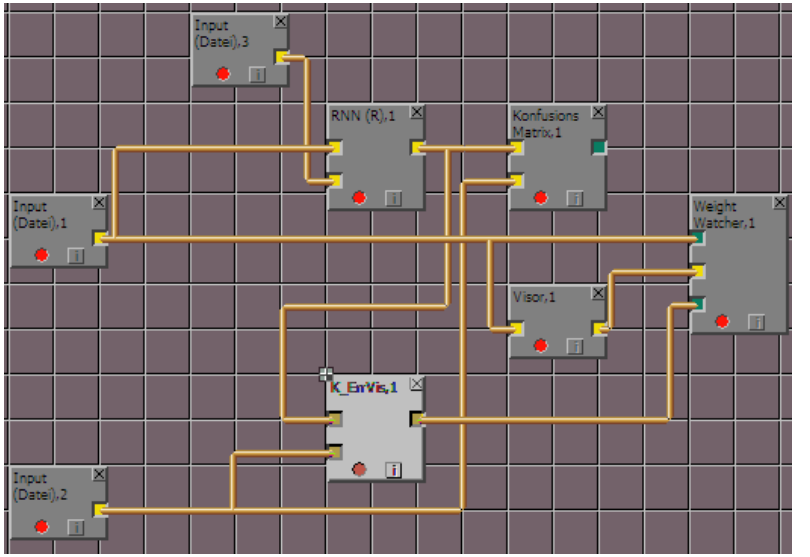
  [1 2 3 4 5 6 7 8 9 10 11 13 14 15 17 18 19 20 21 22 23 26 39 40 41 42 49 50 51 52 53 55 56 58 62];

6.4 Letter Detection —in Quickcog

Training



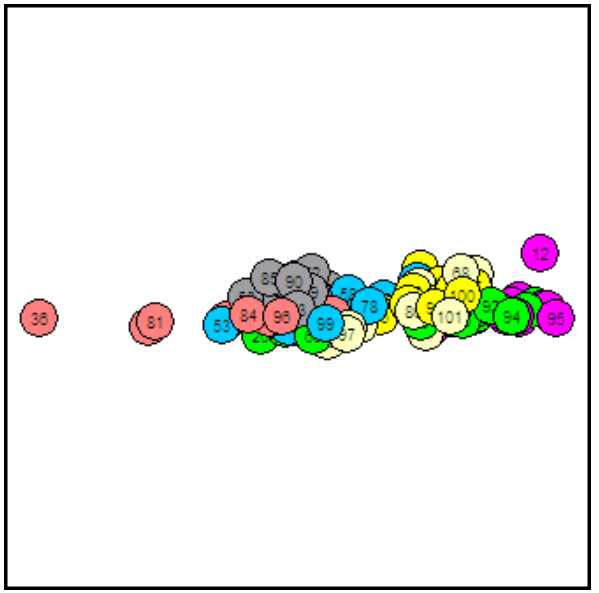
Testing

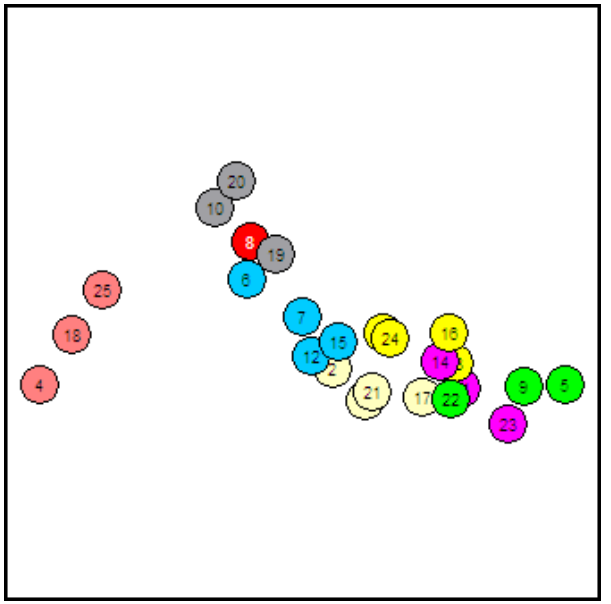


6.5 Letter Detection —Result

- RNN

Train





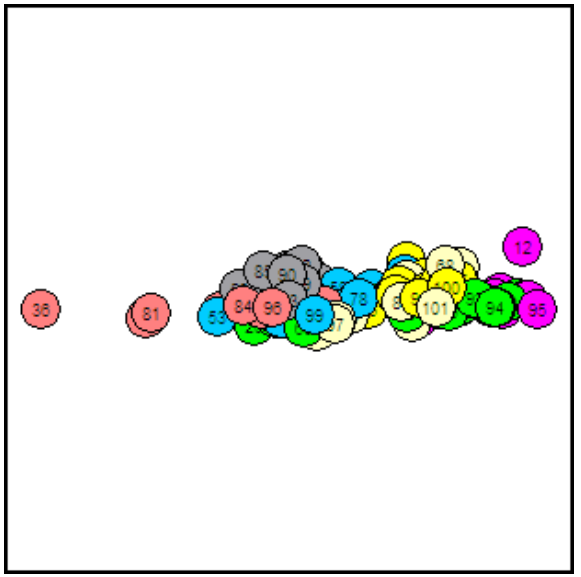
Test

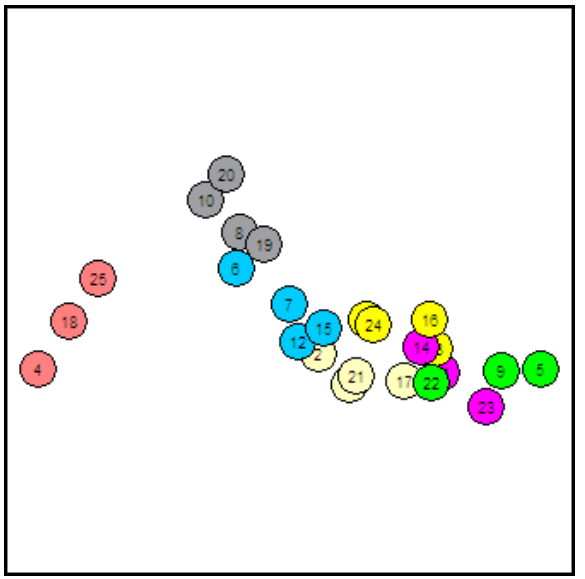
```
Klassifikationsresultate:
Klasse1 (4):  0      (R)    100    0      0      0      0      0      0
Klasse2 (4):  0      (R)    0      100    0      0      0      0      0
Klasse3 (3):  0      (R)    0      0      100    0      0      0      0
Klasse4 (3):  0      (R)    0      0      0      100    0      0      0
Klasse5 (3):  0      (R)    0      0      0      0      100    0      0
Klasse6 (4):  0      (R)    0      0      0      0      0      100    0
Klasse7 (4):  0      (R)    0      25     0      0      0      0      75
Erkennungsrate: 96.000 %
```

6.5 Letter Detection —Result

- KNN

Train





Test

```
Klassifikationsresultate:
Klasse1 (4):  0      (R)    100    0      0      0      0      0      0
Klasse2 (4):  0      (R)    0      100    0      0      0      0      0
Klasse3 (3):  0      (R)    0      0      100    0      0      0      0
Klasse4 (3):  0      (R)    0      0      0      100    0      0      0
Klasse5 (3):  0      (R)    0      0      0      0      100    0      0
Klasse6 (4):  0      (R)    0      0      0      0      0      100    0
Klasse7 (4):  0      (R)    0      0      0      0      0      0      100
Erkennungsrate: 100.000 %
```

Conclusion

- The goal of the project is to reduce the features of the image data, and then recognize the letter with the selected features.
- I use the SFFS/SFBS instead of the SFS/SBS. As the SFFS/SFBS selects much better features than SFS/SBS.
- When do SFFS/SFBS, I use the k-fold method, which matters less how the data gets divided, so it avoids some extreme solution.
- When design the letter detection system, I try several classification method, as one method is not suitable to all kinds of data. The result also shows that the knn is much better than rnn for this image data.

Thank You for your attention!