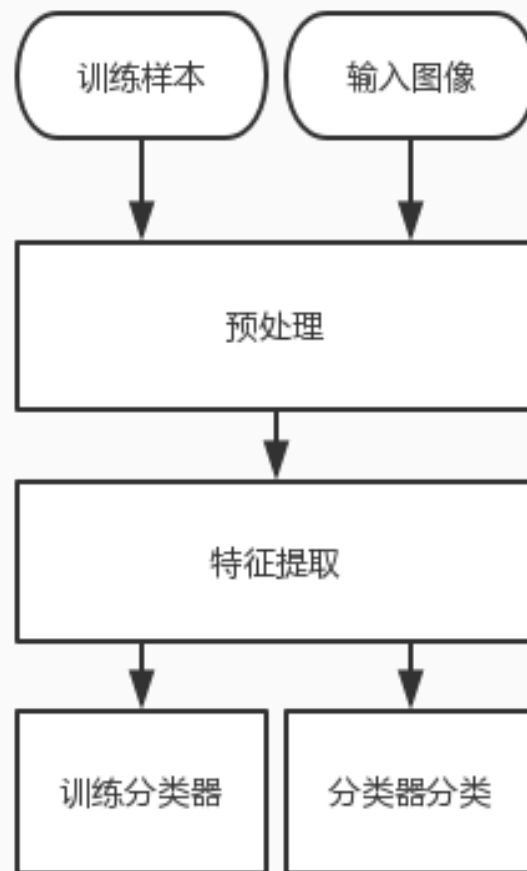


# 基于OpenCV的基本图形识别

章程 2015010912010

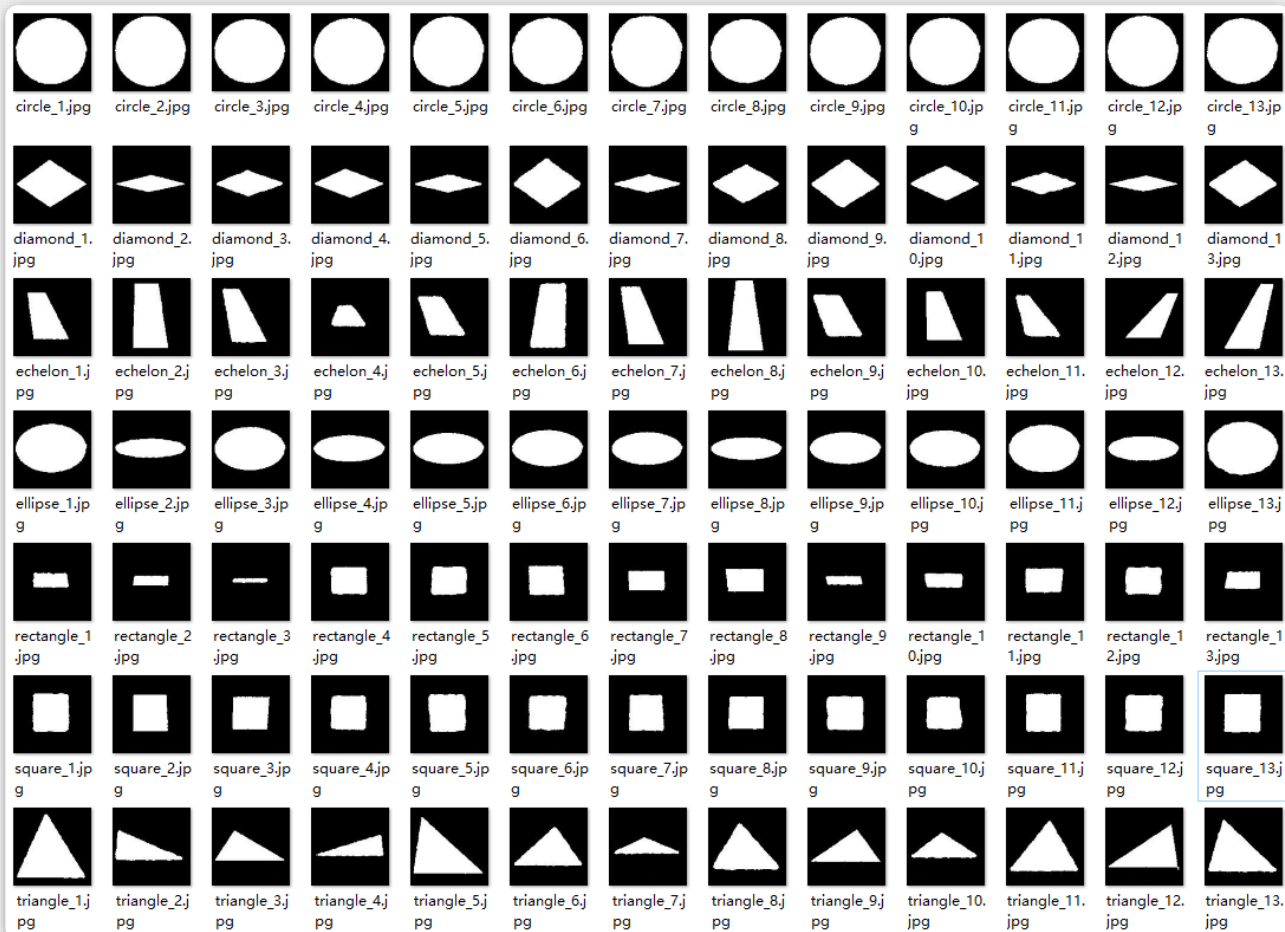


# 图像识别流程



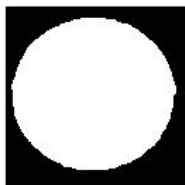
# 训练分类器

## 样本准备——Matlab

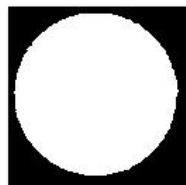


# 训练分类器

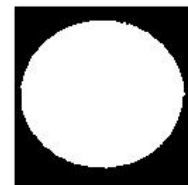
## 样本准备——Matlab



circle\_1.jpg



circle\_2.jpg



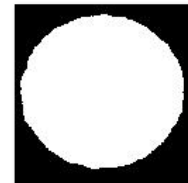
circle\_3.jpg



circle\_4.jpg



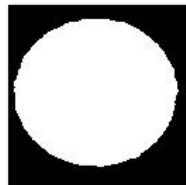
circle\_5.jpg



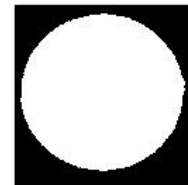
circle\_6.jpg



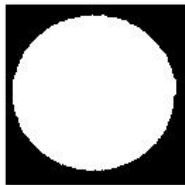
circle\_7.jpg



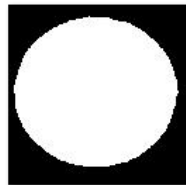
circle\_8.jpg



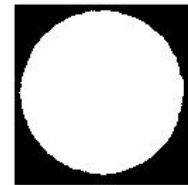
circle\_9.jpg



circle\_10.jpg



circle\_11.jpg



circle\_12.jpg

# 训练分类器

## 样本准备——Matlab



echelon\_2.jpg



echelon\_3.jpg



echelon\_4.jpg



echelon\_5.jpg



echelon\_6.jpg



echelon\_7.jpg



echelon\_8.jpg



echelon\_9.jpg



echelon\_10.jpg



echelon\_11.jpg



echelon\_12.jpg

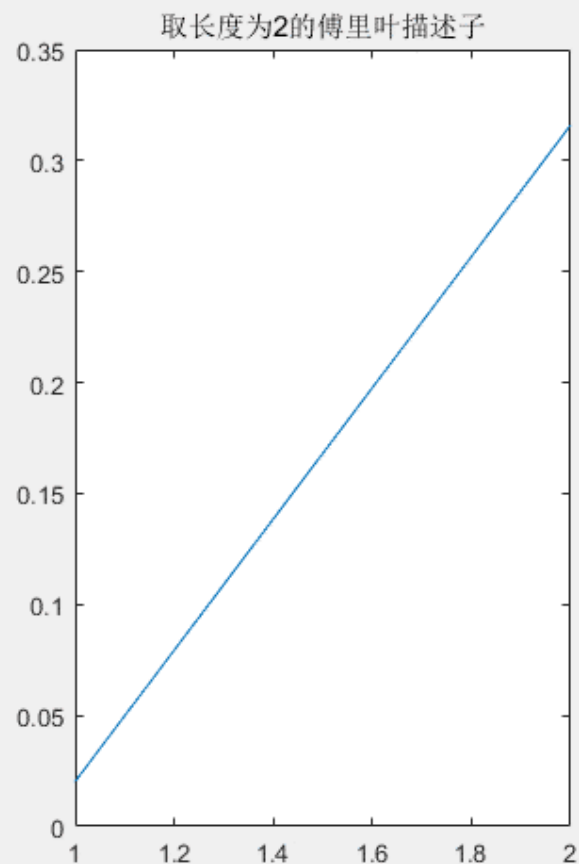
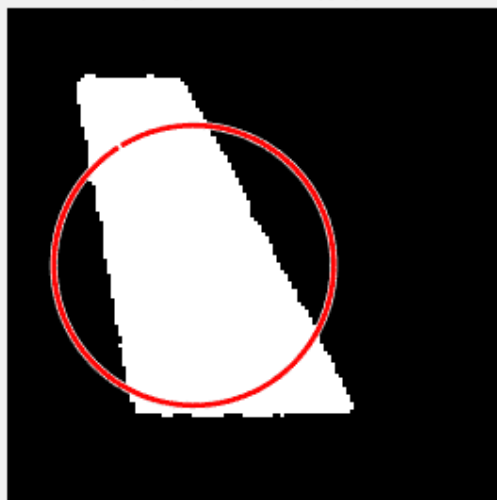


echelon\_13.jpg

# 训练分类器

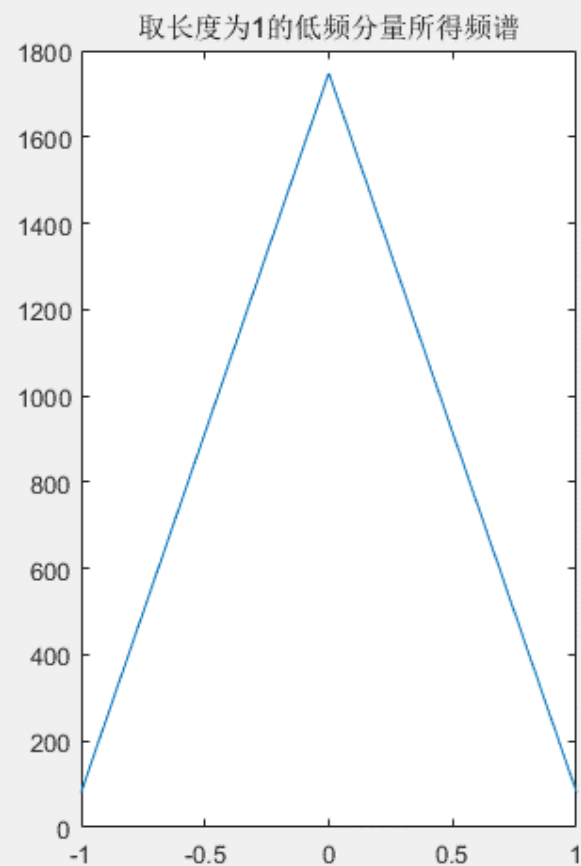
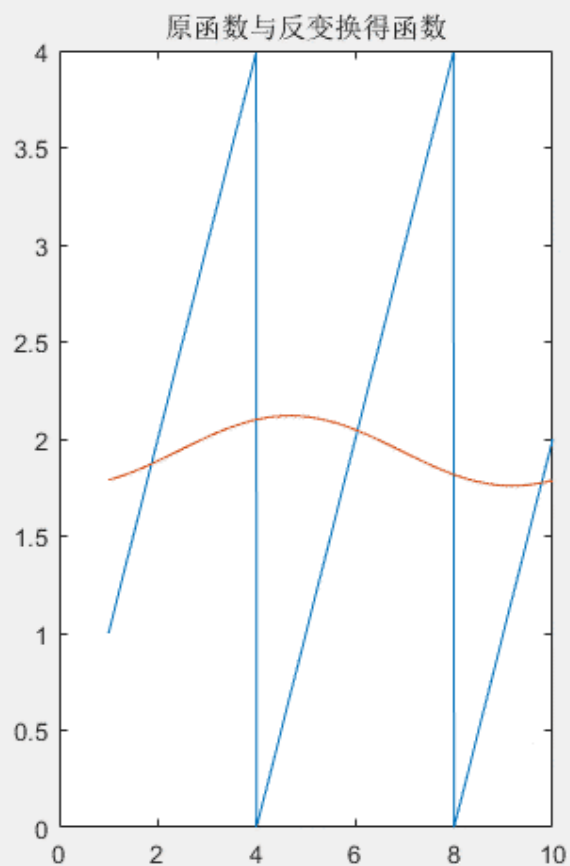
## 特征提取：傅里叶描述子

原图像与傅里叶反变换得轮廓



# 训练分类器

## 特征提取：傅里叶描述子



# 训练分类器

特征提取：傅里叶描述子

$$X(k) = \sum_{n=0}^{N-1} x(n) \cdot W_N^{nk}, \quad 0 \leq k \leq N-1$$

$$x(n) = \frac{1}{N} \sum_{k=0}^{N-1} X(k) \cdot W_N^{-nk}, \quad 0 \leq n \leq N-1$$

$$z(k) = \sum_{n=0}^{N-1} (x(n) + iy(n)) e^{-j\frac{2\pi}{N}kn}$$

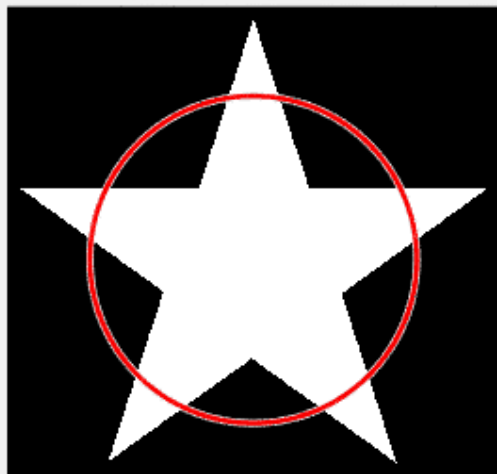
$$p(n) = \frac{1}{N} \sum_{k=0}^{N-1} z(k) e^{j\frac{2\pi}{N}kn}$$



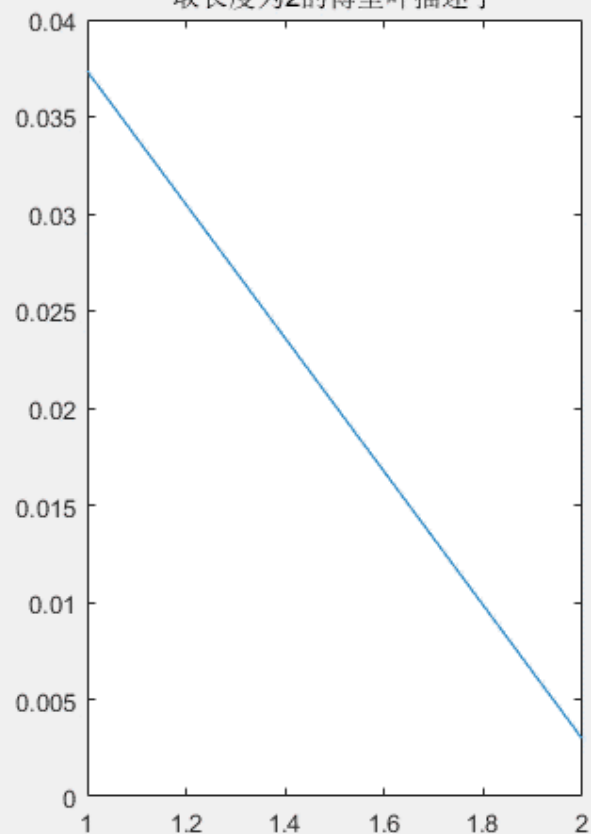
# 训练分类器

## 特征提取：傅里叶描述子

原图像与傅里叶反变换得轮廓



取长度为2的傅里叶描述子



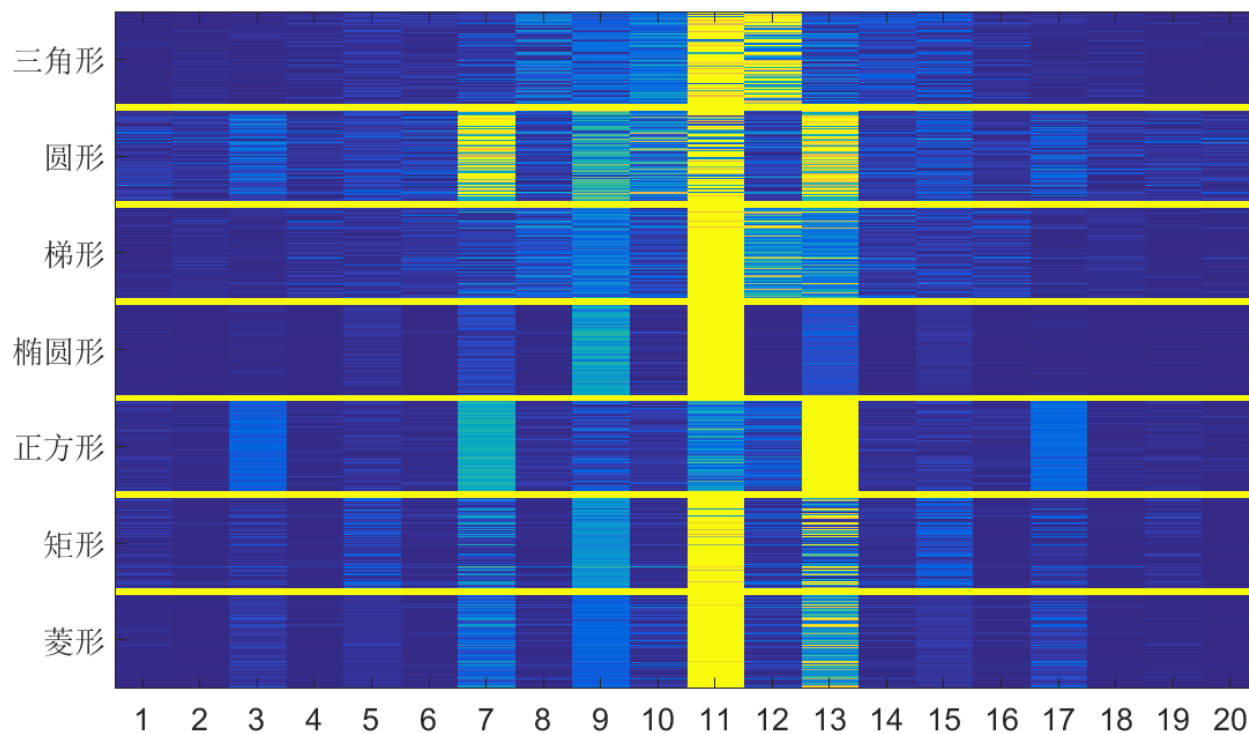
# 训练分类器

## 特征提取：傅里叶描述子

标签	第1维	第2维	第3维	第4维	第5维	第6维	第7维	第8维	第9维	第10维	第11维	第12维	第13维	第14维	第15维	第16维	第17维	第18维	第19维	第20维
'三角形'	0.00285	0.009589	0.003762	0.003659	0.0215	0.004079	0.006255	0.065105	0.008926	0.026716	0.053021	0.238893	0.007158	0.003399	0.035593	0.004635	0.001639	0.011877	0.001112	0.001914
'三角形'	0.010508	0.003531	0.012196	0.005474	0.012283	0.01129	0.042443	0.009962	0.063152	0.12387	0.437388	0.123906	0.09709	0.009365	0.014667	0.011393	0.016941	0.004886	0.004905	0.003776
'三角形'	0.008137	0.005558	0.010324	0.004661	0.012953	0.009918	0.043155	0.014645	0.057062	0.129967	0.365007	0.158027	0.090741	0.015197	0.013038	0.017618	0.015634	0.006338	0.004923	0.008148
'三角形'	0.003553	0.005742	0.011427	0.012784	0.007524	0.006334	0.04383	0.025583	0.043298	0.116327	0.250145	0.193679	0.080918	0.019306	0.006235	0.02717	0.007807	0.006038	0.003793	0.00624
'三角形'	0.004587	0.006468	0.01048	0.009167	0.012279	0.019054	0.017064	0.055153	0.034051	0.058758	0.268373	0.222699	0.027028	0.03433	0.023492	0.008078	0.015888	0.006766	0.002607	0.007744
'三角形'	0.007832	0.008145	0.005387	0.00809	0.017291	0.009179	0.017656	0.053747	0.019376	0.056165	0.145632	0.236453	0.026689	0.016504	0.031027	0.008002	0.006809	0.00771	0.005626	0.005417
'三角形'	0.002144	0.002515	0.012315	0.002963	0.009866	0.022863	0.011146	0.051036	0.046406	0.042641	0.324389	0.22194	0.023868	0.043999	0.021116	0.004808	0.019947	0.001866	0.003283	0.009428
'三角形'	0.007059	0.003374	0.012159	0.002521	0.014588	0.009875	0.03955	0.006774	0.069675	0.100046	0.587442	0.100046	0.107905	0.006774	0.024453	0.009875	0.018252	0.002521	0.007648	0.003374
'三角形'	0.002425	0.008598	0.006831	0.001865	0.023433	0.010721	0.00382	0.064779	0.020427	0.041212	0.269016	0.228279	0.020759	0.02208	0.031409	0.011052	0.010108	0.010771	0.003039	0.005284
'三角形'	0.001548	0.011012	0.000988	0.000759	0.021029	0.001919	0.000639	0.059602	0.002637	0.016472	0.079362	0.253727	0.002617	0.00599	0.038869	0.002565	0.00355	0.016471	0.000937	0.001744
'三角形'	0.004796	0.007623	0.008538	0.005448	0.009165	0.0258	0.013461	0.040457	0.062196	0.058767	0.36341	0.208046	0.035765	0.067561	0.007786	0.007695	0.01883	0.009552	0.007796	0.004617
'三角形'	0.002689	0.006248	0.008185	0.015068	0.003654	0.005132	0.038541	0.034323	0.042214	0.104506	0.187003	0.213676	0.069697	0.018045	0.010432	0.025578	0.001801	0.005342	0.009509	0.005892
'三角形'	0.005965	0.009958	0.005658	0.015413	0.009982	0.026099	0.015945	0.026797	0.090263	0.061306	0.412999	0.160384	0.034172	0.053141	0.011975	0.01105	0.005183	0.007989	0.006587	0.0013
'三角形'	0.000716	0.010296	6.58E-05	0.001097	0.02214	0.000453	0.002829	0.064456	0.00068	0.022857	0.088629	0.24152	0.001953	0.006664	0.036851	0.000268	0.003362	0.013979	0.000404	0.001887
'三角形'	0.000919	0.011461	8.49E-05	0.000725	0.022796	0.003699	0.00104	0.064973	0.003656	0.021364	0.104798	0.234698	0.002712	0.00797	0.033912	0.00201	0.004097	0.013422	0.001093	0.001752
'三角形'	0.00222	0.0081	0.004663	0.011579	0.011387	0.016784	0.028773	0.037729	0.050367	0.081562	0.278107	0.213651	0.055847	0.039543	0.015623	0.01911	0.011939	0.013074	0.005285	0.001666
'三角形'	0.001875	0.007844	0.007121	0.004873	0.017196	0.010984	0.003125	0.06179	0.019577	0.033223	0.244332	0.23406	0.015045	0.022737	0.032054	0.00664	0.008559	0.009853	0.003707	0.004809
'三角形'	0.002851	0.005792	0.005873	0.015204	0.006919	0.012336	0.033872	0.034543	0.049836	0.084518	0.21592	0.200096	0.061875	0.022985	0.014589	0.021657	0.006123	0.006459	0.005754	0.006644
'三角形'	0.007319	0.007764	0.005875	0.009893	0.019818	0.009042	0.01736	0.063975	0.027831	0.041776	0.178237	0.232215	0.014243	0.023422	0.032629	0.008388	0.010166	0.009188	0.006395	0.005313
'三角形'	0.009277	0.002345	0.003138	0.01633	0.011173	0.0106	0.024391	0.049299	0.0328	0.071456	0.137238	0.233261	0.044599	0.015239	0.024739	0.017443	0.00693	0.005969	0.010808	0.001534
'三角形'	0.007234	0.009384	0.007484	0.009698	0.013698	0.0128	0.032748	0.023477	0.122778	0.076244	0.553152	0.110317	0.040594	0.041955	0.018981	0.010255	0.00841	0.004071	0.004257	0.009424
'三角形'	0.006695	0.002918	0.010649	0.003677	0.015573	0.008659	0.037407	0.008279	0.070308	0.100193	0.576891	0.110754	0.11141	0.010412	0.026019	0.011573	0.018277	0.00563	0.01002	0.004002
'三角形'	0.002092	0.009213	0.00635	0.010084	0.010536	0.015618	0.027665	0.04037	0.05387	0.075998	0.297093	0.207628	0.04771	0.043668	0.017442	0.017213	0.012369	0.008997	0.002605	0.002006
'三角形'	0.007062	0.003032	0.003788	0.013357	0.014261	0.008713	0.021928	0.056221	0.024906	0.056214	0.113528	0.239022	0.029963	0.018369	0.03198	0.015633	0.007085	0.009741	0.010114	0.00189
'三角形'	0.00587	0.006602	0.007779	0.008201	0.012866	0.011591	0.017222	0.059599	0.022834	0.056873	0.223935	0.237407	0.021171	0.026085	0.032855	0.010716	0.010326	0.0078	0.004364	0.007406
'三角形'	0.008168	0.002973	0.00946	0.005542	0.023282	0.004548	0.024703	0.023682	0.092035	0.098613	0.552066	0.111775	0.093328	0.024287	0.034194	0.004058	0.009529	0.008081	0.010496	0.005314
'三角形'	0.001982	0.012207	0.001197	0.01716	0.002696	0.016052	0.028167	0.007562	0.113686	0.056339	0.570114	0.115553	0.012745	0.051202	0.011432	0.022237	0.006513	0.008981	0.001395	0.003537
'三角形'	0.007053	0.004878	0.00487	0.016303	0.002231	0.009091	0.038853	0.042657	0.042397	0.085832	0.163702	0.206012	0.054975	0.020291	0.014794	0.023967	0.001487	0.003004	0.009395	0.0042
'三角形'	0.01024	0.001186	0.003255	0.015022	0.010392	0.00989	0.025884	0.050348	0.031635	0.066677	0.086291	0.2395	0.04045	0.018739	0.027569	0.018879	0.006562	0.005014	0.011878	0.000652
'三角形'	0.007311	0.00376	0.014474	0.010422	0.014376	0.012389	0.025145	0.01691	0.111833	0.081154	0.517282	0.122799	0.043953	0.042276	0.025294	0.013402	0.012104	0.005051	0.000689	0.005879
'三角形'	0.006684	0.005161	0.003303	0.018619	0.007389	0.030217	0.012559	0.020901	0.100947	0.058387	0.474275	0.151287	0.015164	0.053984	0.010655	0.012675	0.005273	0.001324	0.007814	0.002267
'三角形'	0.007495	0.002737	0.008447	0.004109	0.019918	0.00491	0.022688	0.022517	0.087576	0.101508	0.551882	0.119229	0.090385	0.029233	0.037063	0.004458	0.009989	0.010015	0.009863	0.005433
'三角形'	0.005129	0.002197	0.01326	0.001963	0.006263	0.025724	0.009901	0.045654	0.053102	0.047805	0.356013	0.212313	0.027041	0.04955	0.015044	0.004581	0.020161	0.001133	0.005467	0.008311
'三角形'	0.008827	0.002609	0.00668	0.002742	0.023125	0.003118	0.036045	0.013427	0.09379	0.072105	0.584451	0.093304	0.090244	0.01738	0.026203	0.007334	0.005653	0.005692	0.010866	0.002426
'三角形'	0.000778	0.00701	0.006902	0.007189	0.017144	0.020528	0.01713	0.022686	0.086503	0.079661	0.436069	0.167426	0.045484	0.053295	0.019916	0.011732	0.007334	0.012133	0.00544	0.007321
'三角形'	0.006528	0.010099	0.005295	0.005863	0.020448	0.01104	0.035917	0.022443	0.071061	0.090089	0.363269	0.167543	0.069979	0.035249	0.017045	0.015722	0.005862	0.012655	0.005321	0.003442
'三角形'	0.010683	0.003884	0.00875	0.002596	0.022539	0.00568	0.030531	0.022166	0.086951	0.105197	0.502186	0.117221	0.087418	0.024669	0.029182	0.007481	0.004971	0.007161	0.008219	0.002107
'三角形'	0.01044	0.000279	0.003041	0.015157	0.010183	0.010779	0.027763	0.052667	0.030316	0.064443	0.082314	0.230225	0.037954	0.019151	0.027755	0.018341	0.005204	0.004156	0.009197	0.002261

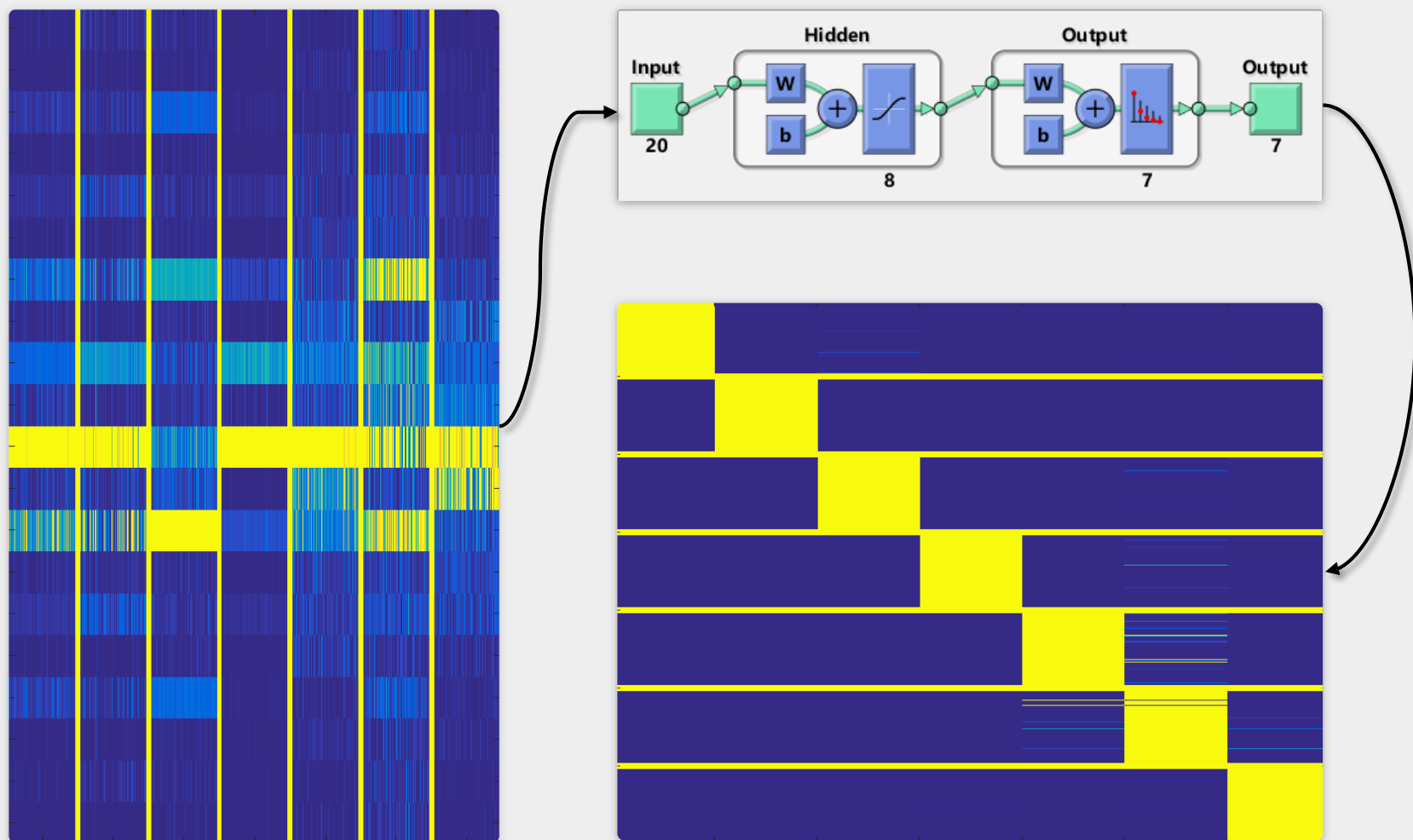
# 训练分类器

特征提取：傅里叶描述子



# 训练分类器

## 神经网络



# 训练分类器

## 神经网络

Training Confusion Matrix

1	1369	0	3	0	0	2	0	99.6%
	14.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%
2	0	1376	0	0	0	0	0	100%
	0.0%	14.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3	1	0	1419	0	0	1	0	99.9%
	0.0%	0.0%	14.5%	0.0%	0.0%	0.0%	0.0%	0.1%
4	0	0	0	1416	0	2	0	99.9%
	0.0%	0.0%	0.0%	14.4%	0.0%	0.0%	0.0%	0.1%
5	0	0	0	0	1365	62	0	95.7%
	0.0%	0.0%	0.0%	0.0%	13.9%	0.6%	0.0%	4.3%
6	0	0	2	0	17	1360	3	98.4%
	0.0%	0.0%	0.0%	0.0%	0.2%	13.9%	0.0%	1.6%
7	0	0	0	0	0	0	1402	100%
	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	14.3%	0.0%
	99.9%	100%	99.6%	100%	98.8%	95.3%	99.8%	99.1%
	0.1%	0.0%	0.4%	0.0%	1.2%	4.7%	0.2%	0.9%
	1	2	3	4	5	6	7	

Validation Confusion Matrix

1	315	0	0	0	0	0	0	100%
	15.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2	0	313	0	0	0	0	0	100%
	0.0%	14.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3	0	0	288	0	0	1	0	99.7%
	0.0%	0.0%	13.7%	0.0%	0.0%	0.0%	0.0%	0.3%
4	0	0	1	298	0	0	0	99.7%
	0.0%	0.0%	0.0%	14.2%	0.0%	0.0%	0.0%	0.3%
5	0	0	0	0	282	7	0	97.6%
	0.0%	0.0%	0.0%	0.0%	13.4%	0.3%	0.0%	2.4%
6	0	0	0	0	9	280	0	96.9%
	0.0%	0.0%	0.0%	0.0%	0.4%	13.3%	0.0%	3.1%
7	0	0	2	0	0	0	304	99.3%
	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	14.5%	0.7%
	100%	100%	99.0%	100%	96.9%	97.2%	100%	99.0%
	0.0%	0.0%	1.0%	0.0%	3.1%	2.8%	0.0%	1.0%
	1	2	3	4	5	6	7	

Test Confusion Matrix

1	315	0	0	0	0	0	0	100%
	15.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2	0	311	0	0	0	0	0	100%
	0.0%	14.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3	0	0	285	0	0	0	0	100%
	0.0%	0.0%	13.6%	0.0%	0.0%	0.0%	0.0%	0.0%
4	0	0	0	286	0	1	0	99.7%
	0.0%	0.0%	0.0%	13.6%	0.0%	0.0%	0.0%	0.3%
5	0	0	0	0	324	10	0	97.0%
	0.0%	0.0%	0.0%	0.0%	15.4%	0.5%	0.0%	3.0%
6	0	0	0	0	3	274	0	98.9%
	0.0%	0.0%	0.0%	0.0%	0.1%	13.0%	0.0%	1.1%
7	0	0	0	0	0	0	291	100%
	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	13.9%	0.0%
	100%	100%	100%	100%	99.1%	96.1%	100%	99.3%
	0.0%	0.0%	0.0%	0.0%	0.9%	3.9%	0.0%	0.7%
	1	2	3	4	5	6	7	

All Confusion Matrix

1	1999	0	3	0	0	2	0	99.8%
	14.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%
2	0	2000	0	0	0	0	0	100%
	0.0%	14.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3	1	0	1992	0	0	2	0	99.8%
	0.0%	0.0%	14.2%	0.0%	0.0%	0.0%	0.0%	0.2%
4	0	0	1	2000	0	3	0	99.8%
	0.0%	0.0%	0.0%	14.3%	0.0%	0.0%	0.0%	0.2%
5	0	0	0	0	1971	79	0	96.1%
	0.0%	0.0%	0.0%	0.0%	14.1%	0.6%	0.0%	3.9%
6	0	0	2	0	29	1914	3	98.3%
	0.0%	0.0%	0.0%	0.0%	0.2%	13.7%	0.0%	1.7%
7	0	0	2	0	0	0	1997	99.9%
	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	14.3%	0.1%
	100%	100%	99.6%	100%	98.6%	95.7%	99.9%	99.1%
	0.0%	0.0%	0.4%	0.0%	1.4%	4.3%	0.1%	0.9%
	1	2	3	4	5	6	7	

# 训练分类器

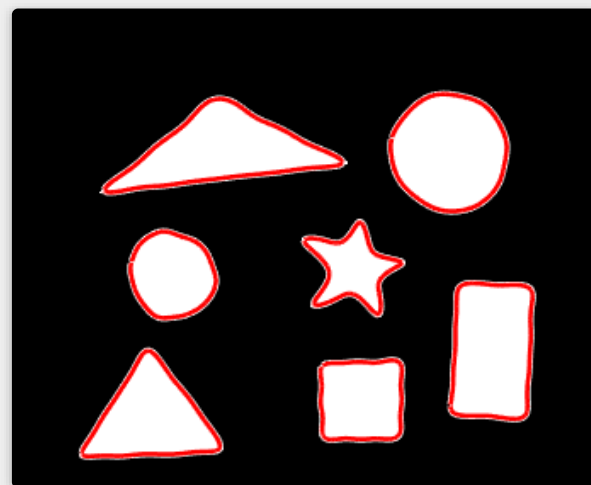
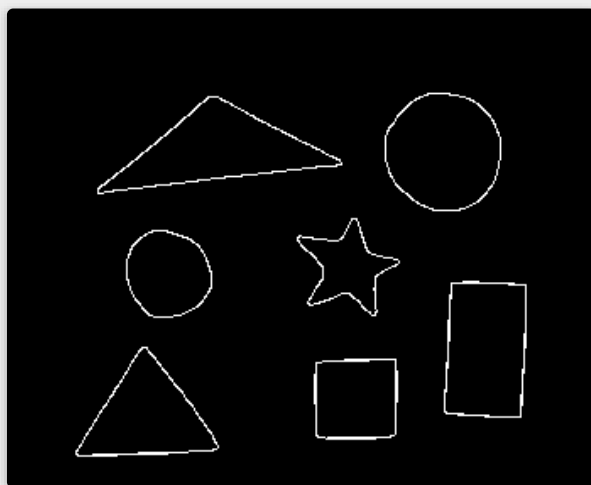
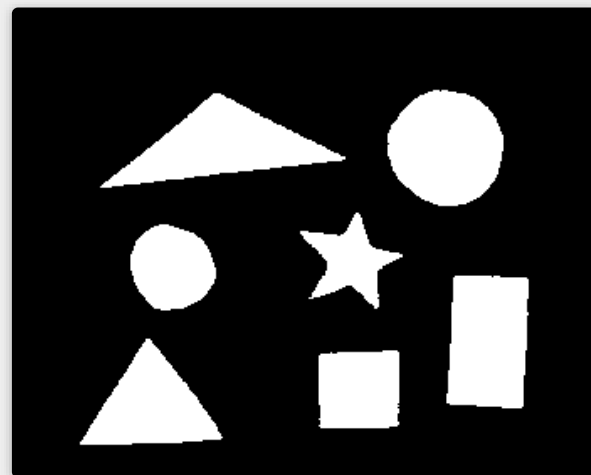
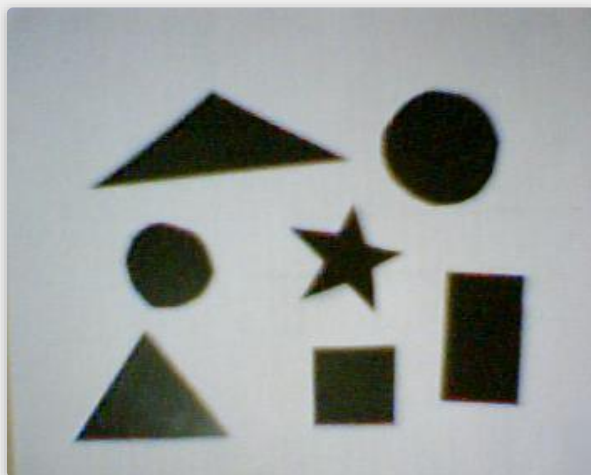
## 神经网络

### All Confusion Matrix

Output Class	1	2	3	4	5	6	7	
1	1999 14.3%	0 0.0%	3 0.0%	0 0.0%	0 0.0%	2 0.0%	0 0.0%	99.8% 0.2%
2	0 0.0%	2000 14.3%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	100% 0.0%
3	1 0.0%	0 0.0%	1992 14.2%	0 0.0%	0 0.0%	2 0.0%	0 0.0%	99.8% 0.2%
4	0 0.0%	0 0.0%	1 0.0%	2000 14.3%	0 0.0%	3 0.0%	0 0.0%	99.8% 0.2%
5	0 0.0%	0 0.0%	0 0.0%	0 0.0%	1971 14.1%	79 0.6%	0 0.0%	96.1% 3.9%
6	0 0.0%	0 0.0%	2 0.0%	0 0.0%	29 0.2%	1914 13.7%	3 0.0%	98.3% 1.7%
7	0 0.0%	0 0.0%	2 0.0%	0 0.0%	0 0.0%	0 0.0%	1997 14.3%	99.9% 0.1%
	100.0% 0.0%	100% 0.0%	99.6% 0.4%	100% 0.0%	98.6% 1.4%	95.7% 4.3%	99.9% 0.1%	99.1% 0.9%
	1	2	3	4	5	6	7	
	Target Class							

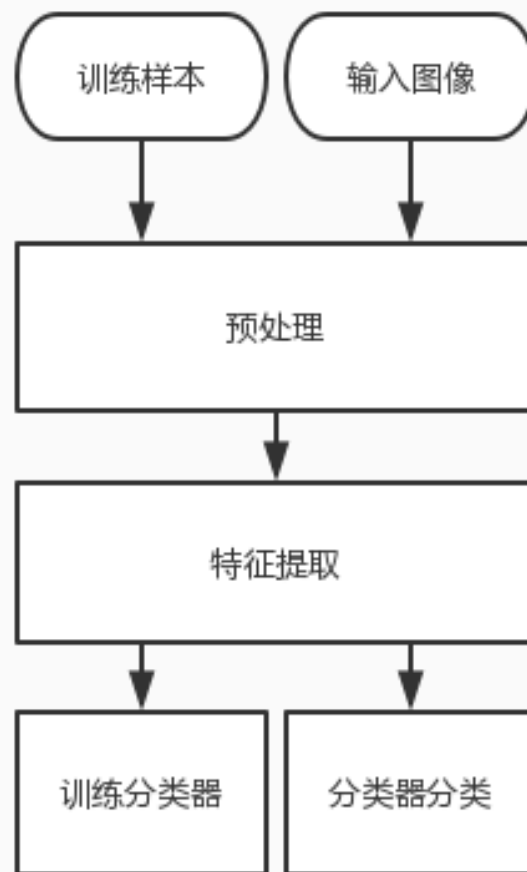
# 图像识别

## 预处理



# 图像识别

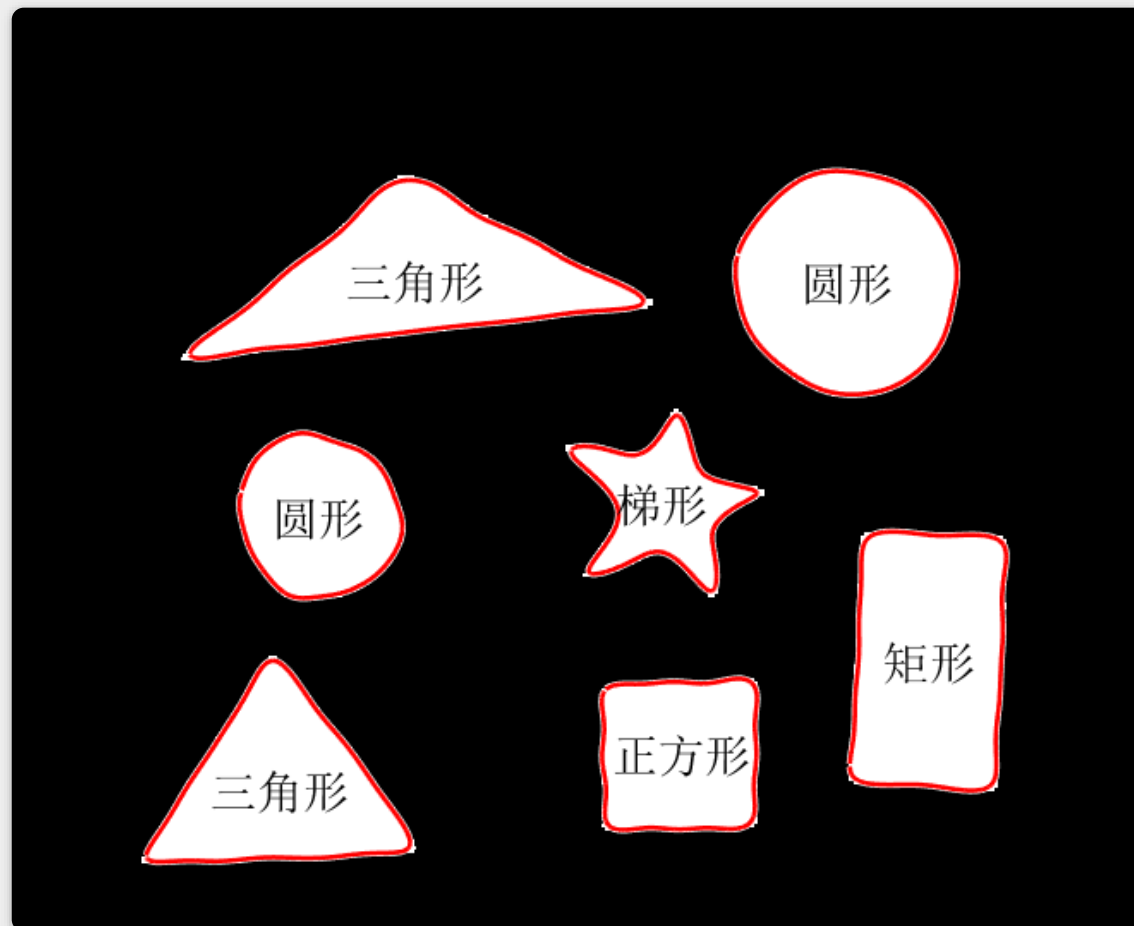
特征提取、分类器分类





# 图像识别

叠加标签



# 图像识别

OpenCV + QT

## 形状识别

选取图片

摄像头输入

预处理方法: OTSU (默认)

摄像头ID:

0

面积阈值:



## 重置神经网络和样本

隐含层数:

1

层节点数:

8

重置

## 点击图形纠错

选择类别:

菱形

添加类别:

添加

增加步长:

30

添加噪声:

5

像素

微调神经网络

## 保存或还原神经网络和样本

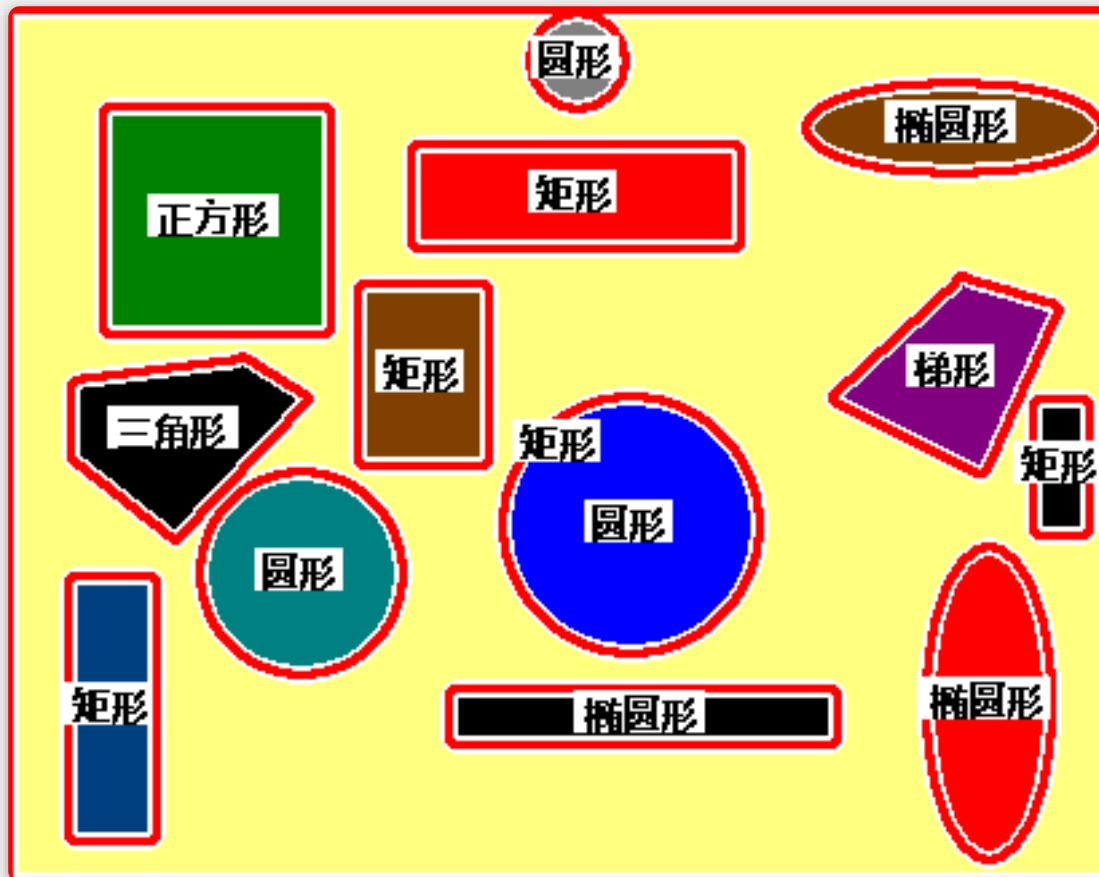
保存

还原

基本形状识别——章程 2015010912010

# 图像识别

OpenCV + QT



# 图像识别

OpenCV + QT

统计结果：

三角形： 2

椭圆形： 1

正方形： 2

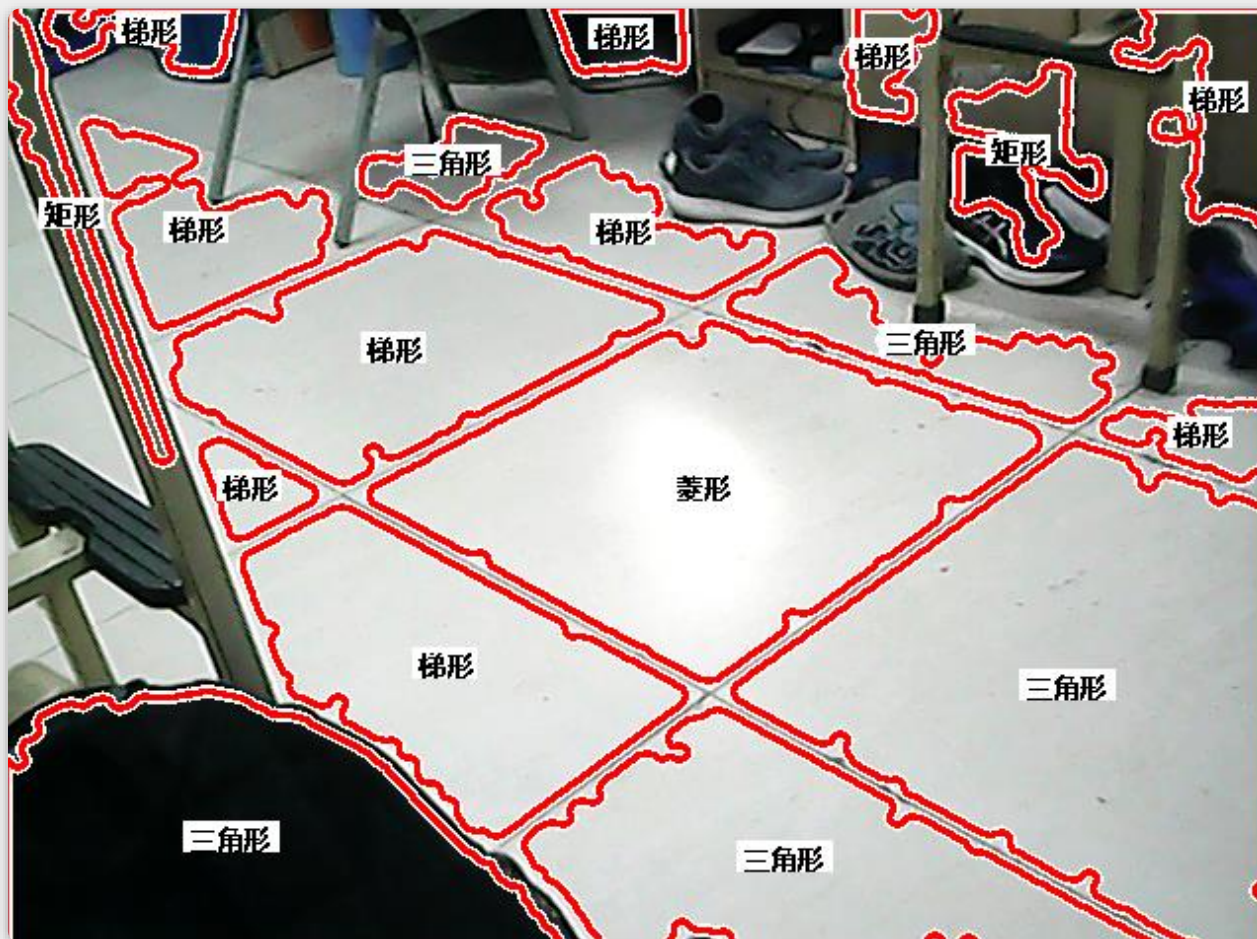
矩形： 4

菱形： 1

单击选择高亮轮廓以纠错！

# 图像识别

OpenCV + QT



# 图像识别

## 演示

### 形状识别

选取图片

摄像头输入

预处理方法: OTSU (默认)

摄像头ID:

0

面积阈值:



### 重置神经网络和样本

隐含层数:

1

层节点数:

8

重置

### 点击图形纠错

选择类别:

菱形

添加类别:

添加

增加步长:

30

添加噪声:

5

像素

微调神经网络

### 保存或还原神经网络和样本

保存

还原

基本形状识别——章程 2015010912010