

Character recognition: neural network application

Machine intelligence class

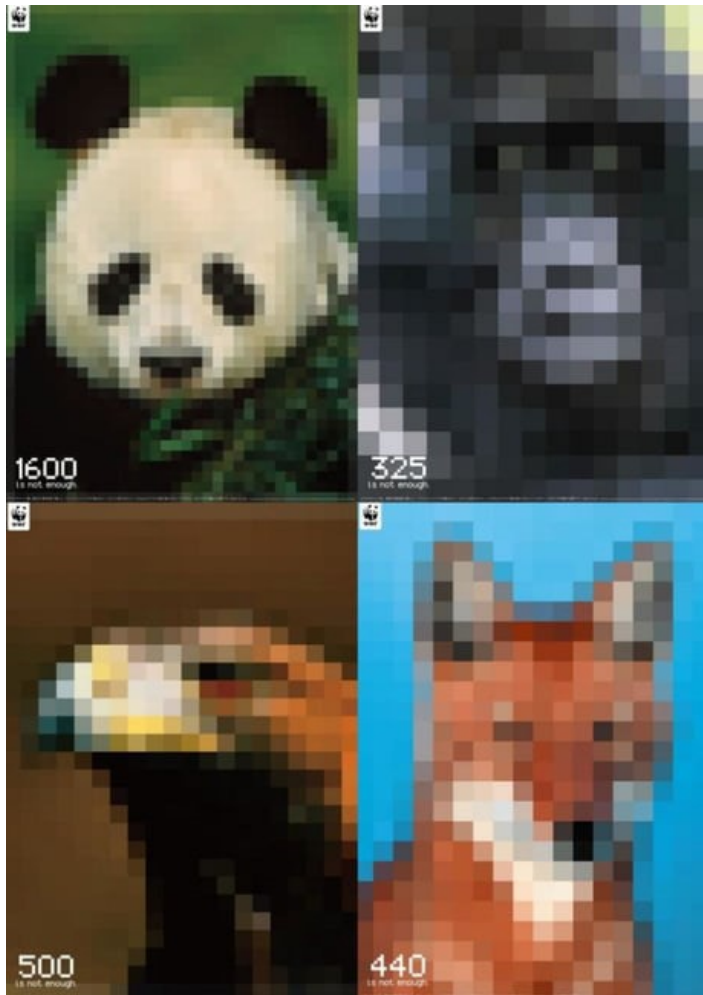


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Outline

- Color and RGB images
- Gray images
- Black and white images
- Number recognition example using ANN

Color Images

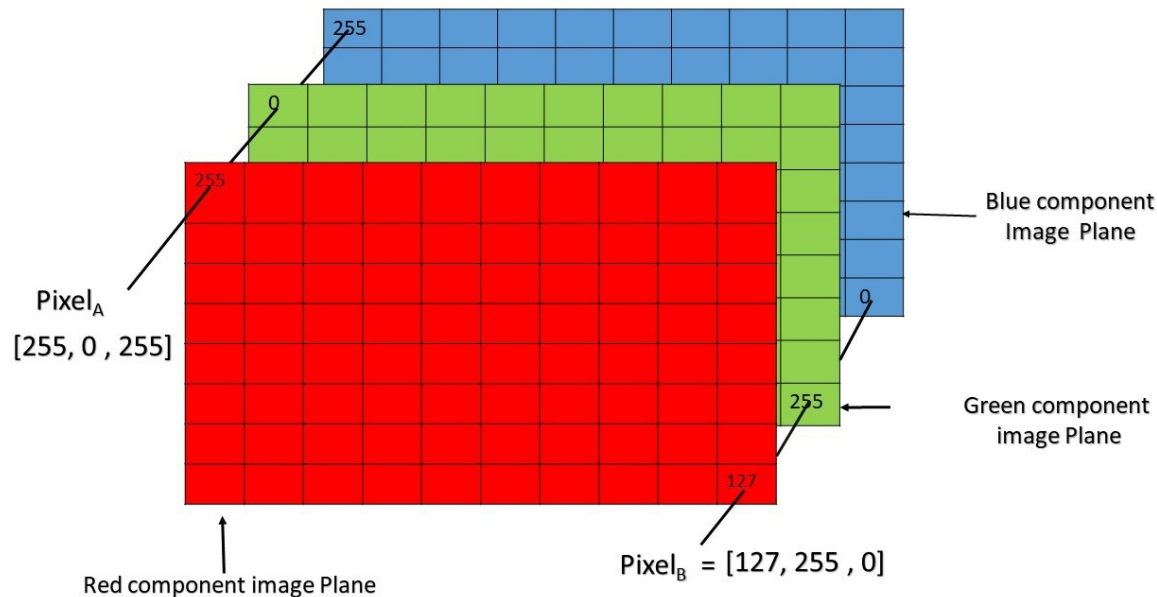


Images are divided into pixels

The number of pixels depends on the resolution of the image

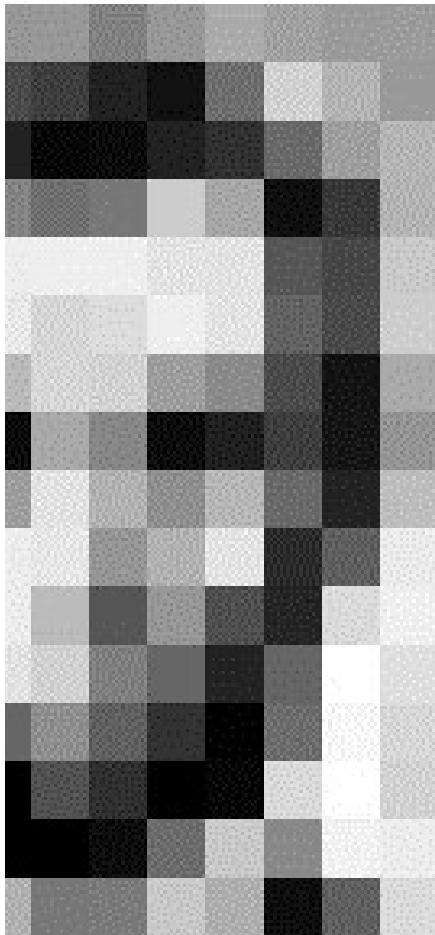
RGB Images

- The color of each **pixel** is determined by the combination of the **Red**, **Green**, and **Blue** intensities stored in each color plane at the **pixel's** location.
- Graphics file formats store **RGB images** as **24-bit images**, where the red, green, and blue components are 8 bits each (i.e. 256 possible combinations for each color)



Pixel of an RGB image are formed from the corresponding pixel of the three component images

Gray Scale Images



157	153	174	168	150	152	129	151	172	161	155	156
156	182	163	74	75	62	33	17	110	210	180	154
180	180	50	14	34	6	10	33	43	105	159	181
206	109	5	124	131	111	120	204	165	15	55	180
194	68	137	251	237	239	239	228	227	67	71	201
172	105	207	233	233	214	220	239	228	98	74	206
188	68	179	209	185	215	211	158	139	75	20	169
189	97	165	84	10	168	134	11	31	62	22	148
199	168	191	193	158	227	178	143	162	105	35	190
205	174	155	252	236	231	149	178	228	43	95	234
190	216	116	149	236	187	85	150	73	38	218	241
190	224	147	108	227	210	127	102	35	101	255	224
190	214	173	66	103	143	95	59	2	109	249	215
187	196	235	75	1	81	47	0	6	217	255	211
183	202	237	145	0	0	12	108	200	138	243	236
195	206	123	207	177	121	123	209	175	13	95	218

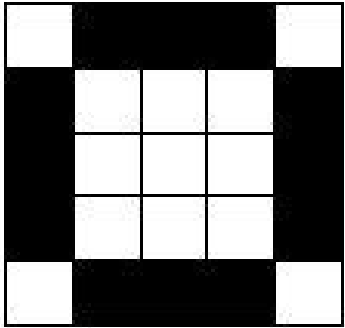
157	153	174	168	150	152	129	151
156	182	163	74	75	62	33	17
180	180	50	14	34	6	10	33
206	109	5	124	131	111	120	204
194	68	137	251	237	239	239	228
172	105	207	233	233	214	220	239
188	68	179	209	185	215	211	158
189	97	165	84	10	168	134	11
199	168	191	193	158	227	178	143
205	174	155	252	236	231	149	178
190	216	116	149	236	187	85	150
190	224	147	108	227	210	127	102
190	214	173	66	103	143	95	59
187	196	235	75	1	81	47	0
183	202	237	145	0	0	12	108
195	206	123	207	177	121	123	209

Gray Scale images uses one 8-bit component

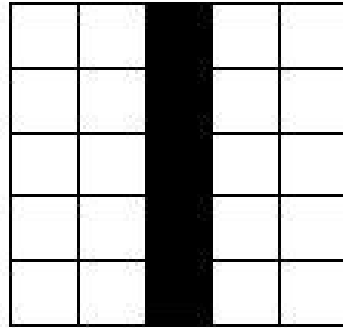
Numbers in Black and White

0 1 2 3 4 5 6 7 8 9

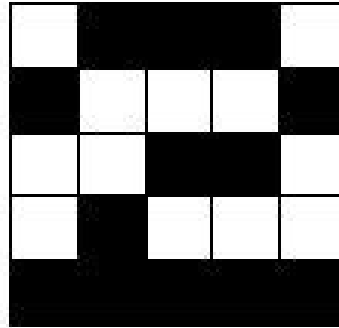
Each number is decoded into black/white 5x5 pixel image Each pixel is either '0' or '1'



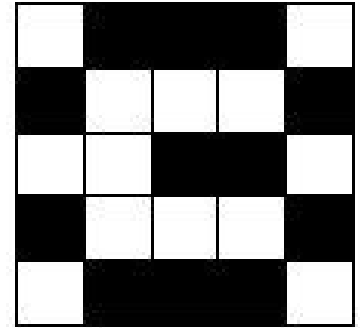
t=0



t=1

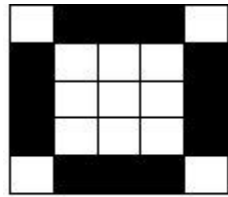


t=2

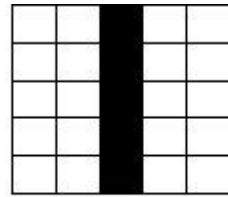


t=3

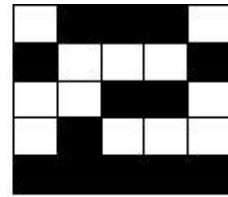
Numbers in Black and White



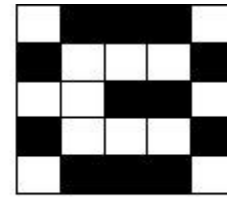
t=0



t=1



t=2



t=3



Create a 5x5 matrix with '0' or '1'

1	0	0	0	1
0	1	1	1	0
0	1	1	1	0
0	1	1	1	0
1	0	0	0	1

Restructure the 5x5 matrix into 25x1 vector



This vector will be the input to the network

Flattening

1
0
0
0
1
0
1
1
1
0
...
1
0
0
0
1

Handwritten Numbers

0 1 2 3 4 5 6 7 8 9

0 1 2 3 4 5 6 7 8 9

0 1 2 3 4 5 6 7 8 9

0 1 2 3 4 5 6 7 8 9

0 1 2 3 4 5 6 7 8 9

0 1 2 3 4 5 6 7 8 9

0 1 2 3 4 5 6 7 8 9

Suppose we want to use a neural network to recognize the handwritten numbers shown

If each number is 5x5 pixel → 25 inputs

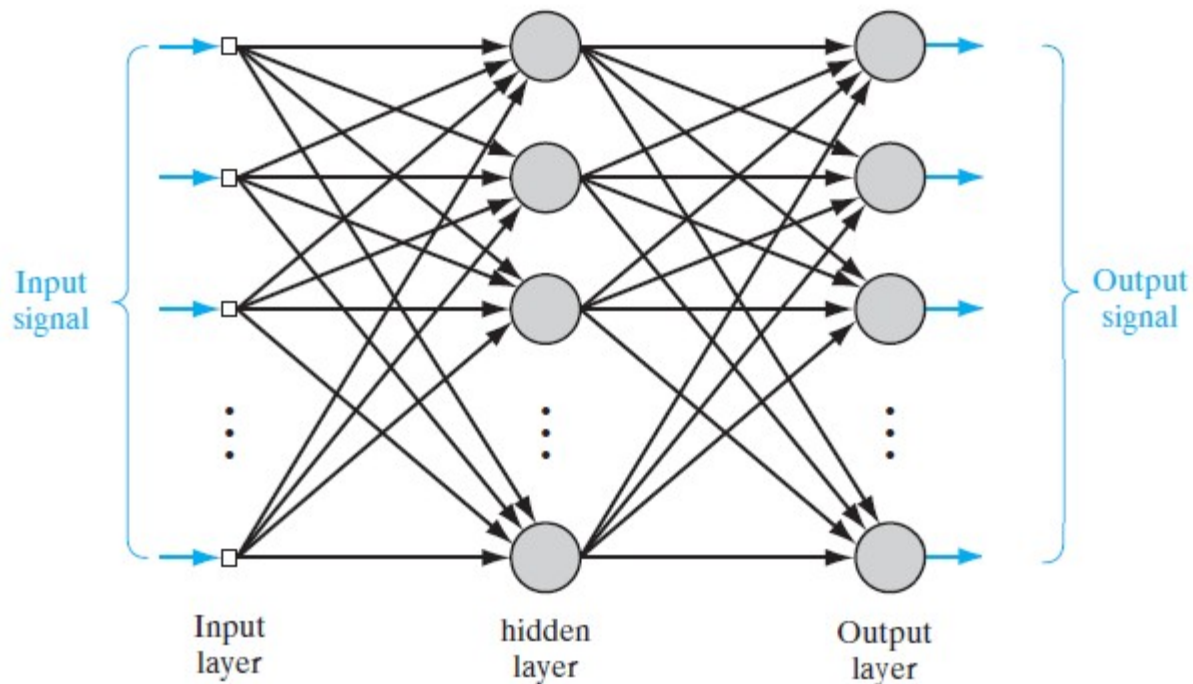
How many outputs?

How many patterns?

Neural Network Architecture

25 Inputs

10 outputs



Use Backpropagation and update the weights to minimize the error

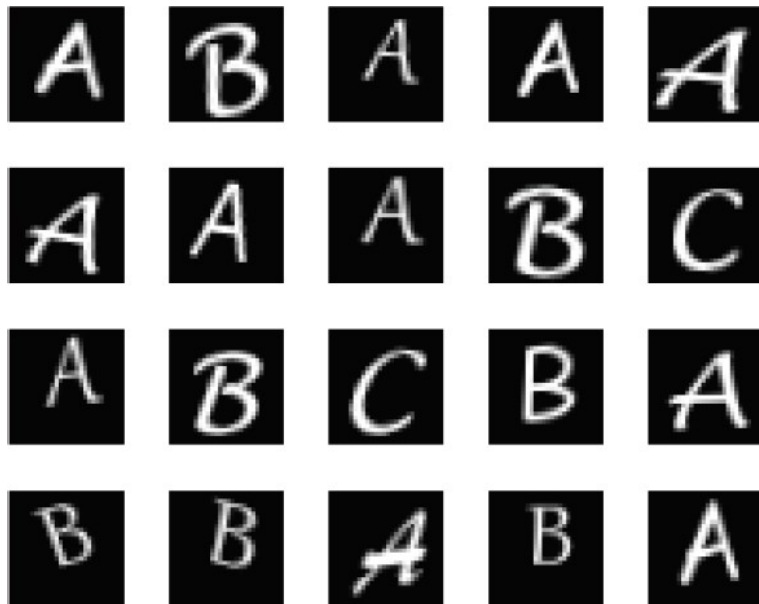
Input-Output Data using simple coding

IN	OUTPUT			
X	d3	d2	d1	d0
'0'	0	0	0	0
'1'	0	0	0	1
'2'	0	0	1	0
'3'	0	0	1	1
'4'	0	1	0	0
'5'	0	1	0	1
'6'	0	1	1	0
'7'	0	1	1	1
'8'	1	0	0	0
'9'	1	0	0	1

Reduce the output neurons
from 10 to only 4

Images of Alphabet: A, B, and C

28 x 28 black/white images



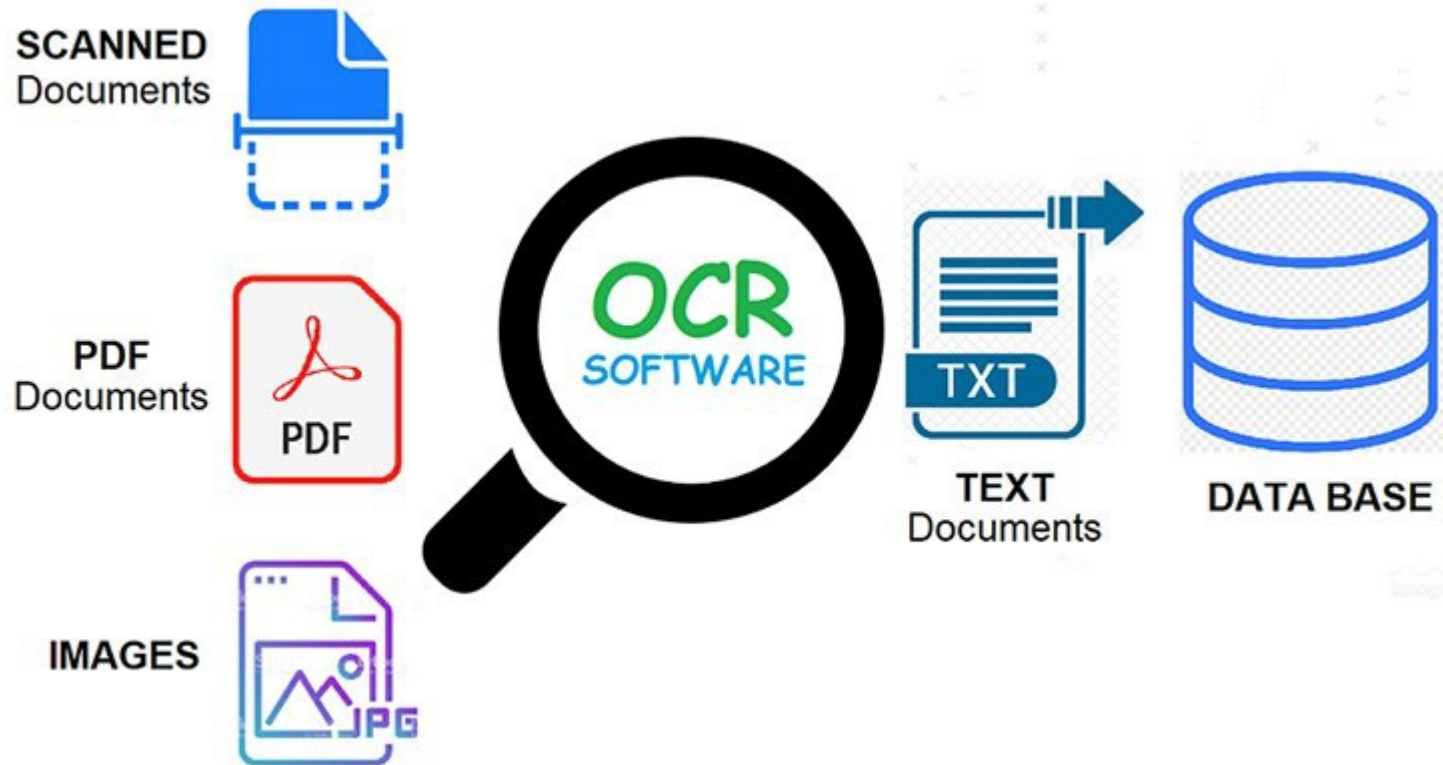
Using a Neural Network for recognition

How many inputs?

How many outputs?

How many patterns?

Image Recognition



Conclusion

- Images are divided into pixels
- Color images use RGB code
- Images are processed using filters
- Neural networks can be used to recognize images