250	250	255	246	249	251	245	251	250	250
249	255	246	206	118	97	183	241	255	250
253	253	218	60	8	6	28	203	254	254
255	242	226	89	37	45	89	214	230	253
254	231	208	235	122	112	235	213	217	255
254	238	203	253	139	111	254	204	228	251
255	234	229	196	114	101	155	230	233	255
253	247	254	55	93	132	0	215	252	253
251	253	236	144	74	74	121	221	255	252
250	255	249	242	218	209	239	246	253	249

250	250	255	236	216	209	231	255	252	250
251	254	234	161	78	52	120	223	255	250
253	255	173	43	5	8	4	148	255	255
255	249	123	0	50	60	2	101	217	255
255	230	94	54	53	25	119	113	179	255
255	226	130	214	49	2	150	136	208	255
255	216	218	205	109	94	147	216	210	255
254	244	237	47	87	122	0	178	243	255
251	254	197	69	61	60	51	165	255	252
248	255	250	203	156	137	188	249	253	249

250	250	253	224	103	97	202	252	251	252
248	255	212	6	8	21	4	183	253	248
253	254	54	35	118	119	64	31	239	255
253	205	2	73	103	103	83	0	175	252
255	165	0	0	58	67	0	0	132	253
253	150	2	23	74	83	65	27	119	255
253	150	50	236	77	42	255	109	106	255
255	229	33	120	53	37	127	35	202	254
251	255	138	2	68	83	0	106	255	252
249	253	252	148	33	29	122	254	253	249

Figure 35-3. *Colored image with matrix representation*

Local Receptive Fields of the Visual Cortex

The core concept of convolutional neural networks is built on understanding the local receptive fields found in the neurons of the visual cortex – the part of the brain responsible for processing visual information.

A local receptive field is an area on the neuron that excites or activates that neuron to fire information to other neurons. When viewing an image, the neurons in the visual cortex react to a small or limited area of the overall image due to the presence of a small local receptive field.

Hence, the neurons in the visual cortex do not all sense the entire image at the same time, but they are activated by viewing a local area of the image via its local receptive field.

In Figure 35-4, the local receptive fields overlap to give a collective perspective on the entire image. Each neuron in the visual cortex reacts to a different type of visual information (e.g., lines with different orientations).

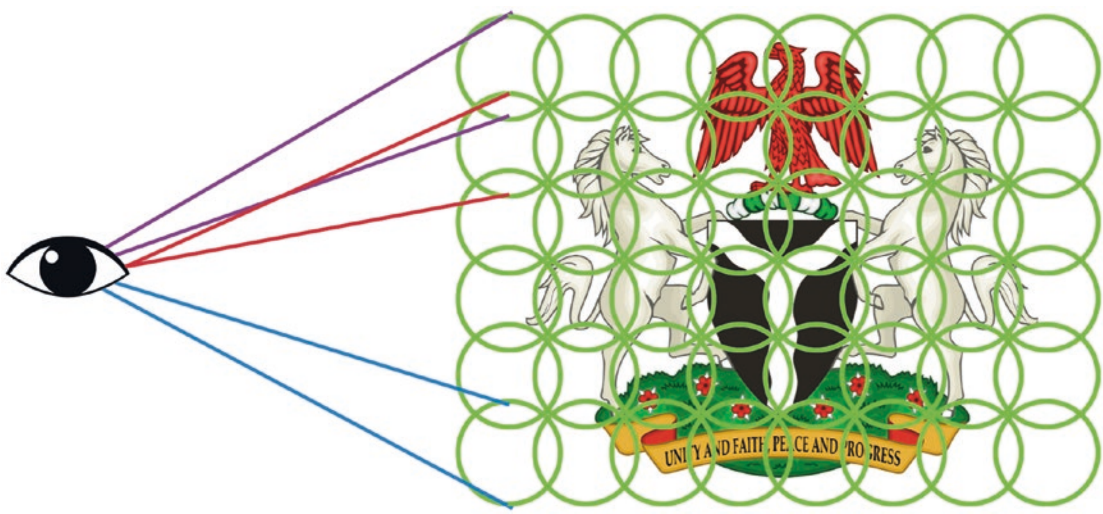

Figure 35-4. *Local receptive field*

Other neurons have large receptive fields that react to more complex visual patterns such as edges, regions, and so on. From here we get the idea that neurons with larger receptive field receive information from those with lower receptive fields as they progressively learn the visual information of the image.

Advantages of CNN over MLP

Suppose we have a 28 x 28 pixel set of image data, a feedforward neural network or multilayer perceptron will need 784 input weights plus a bias. By flattening an image as you would in MLP, we lose the spatial relationship of the pixels in the image.

CNN, on the other hand, can learn complex image features by preserving the spatial relationship between the image pixels. It does so by stacking convolutional layers whereby the neurons in the higher layers with a larger receptive field receive information