Level 3:
Detect connected areas

Given a set of luminosity values, we need to determine the connected areas.

Input: nrOfRows nrOfColumns 2D-image-data

nrOfRows = number of rows of the 2D image

nrOfColumns = number of cols of the 2D image

2D-image-data = list of luminosity-values (with nrOfRows x nrOfColumns elements)

luminosity-value = number from 0 .. 7 (0 .. dark ; 7 .. bright)

Output: Input of level 2 (i.e. image with connected areas of same brightness)

Example (see also next page)

Input: 12 19 0 0 0 0 …

```
0 0 4 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 4 4 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 4 0 0 0 0 0 0 0 0 0 5 5 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 5 5 5 5 5 0 0
0 0 0 6 6 0 2 2 0 0 0 0 5 5 5 5 5 0 0 0
0 6 6 6 0 2 2 2 2 0 0 0 5 5 5 5 0 0 0 0
0 0 6 6 0 0 2 2 2 0 0 0 0 5 5 0 0 0 0 0
0 0 6 6 6 0 2 2 2 0 0 1 1 1 1 0 0 0 0 0
0 0 6 6 6 0 2 2 2 0 1 1 1 1 1 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

Output: 12 19 0 0 0 0 …

```
0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 1 0 0 0 0 0 0 0 0 0 2 2 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 2 2 2 2 2 0 0
0 0 0 3 3 0 4 4 0 0 0 0 2 2 2 2 2 0 0 0
0 3 3 3 0 4 4 4 4 0 0 0 2 2 2 2 0 0 0 0
0 0 3 3 0 0 4 4 4 0 0 0 0 2 2 0 0 0 0 0
0 0 3 3 3 0 4 4 4 0 0 5 5 5 5 0 0 0 0 0
0 0 3 3 3 0 4 4 4 0 5 5 5 5 5 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 5 5 5 5 5 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

5 1 4 2 5 3 6 4 2 5 1

Example (continued)

Input: 12 19 0 0 0 0 …

```
0 0 4 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 4 4 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 4 0 0 0 0 0 0 0 0 0 5 5 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 5 5 5 5 5 0 0 0
0 0 0 6 6 0 2 2 0 0 0 0 5 5 5 5 5 0 0 0
0 6 6 6 0 2 2 2 2 0 0 0 5 5 5 5 0 0 0 0
0 0 6 6 0 0 2 2 2 0 0 0 5 5 0 0 0 0 0 0
0 0 6 6 6 0 2 2 2 0 1 1 1 1 0 0 0 0 0 0
0 0 6 6 6 0 2 2 2 0 1 1 1 1 1 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

The ellipses mark connected areas.
Give each connected area an ID

Output: 12 19 0 0 0 0 …

```
0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 1 0 0 0 0 0 0 0 0 0 2 2 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 2 2 2 2 2 0 0 0
0 0 0 3 3 0 4 4 0 0 0 0 2 2 2 2 2 0 0 0
0 3 3 3 0 4 4 4 4 0 0 0 2 2 2 2 0 0 0 0
0 0 3 3 0 0 4 4 4 0 0 0 0 2 2 0 0 0 0 0
0 0 3 3 3 0 4 4 4 0 0 5 5 5 5 0 0 0 0 0
0 0 3 3 3 0 4 4 4 0 5 5 5 5 5 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 5 5 5 5 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

5 1 4 2 5 3 6 4 2 5 1