

The following is the proposed method of our group:

1. Connected Components

The first step is to identify all of the distinct components or objects in the given image. We use a  $3 \times 3$  structuring element  $B$  for the connected component analysis so that the 8 connected pixels: up, down, left, right, and diagonals are considered part of the same component.

2. Bounding Box Generation

The second step would be to generate bounding boxes around each of the identified connected components. To generate these boxes, each component must be handled separately. This can be done using the labels given to each component through the connected components implementation. Once each individual component has been isolated from the others, the  $x$ -coordinates of the leftmost and rightmost pixels and the  $y$ -coordinates of the topmost and bottommost pixels of the component will be stored. These will serve as its boundaries and will be useful in locating the components.

3. Hole-Filling

Lastly, a hole-filling algorithm will be implemented to determine whether the component contains any holes.

The goal of the hole-filling algorithm is to fill the holes with the foreground element, in this case, the color white. We check for any difference between the original shape of a component and its corresponding hole-filled shape. If there is a difference, this implies that the component contained holes; otherwise, the component did not contain any holes. Once this has been identified, the boundaries of the component will be stored in the appropriate list (or bin) – for components with holes or components without holes.