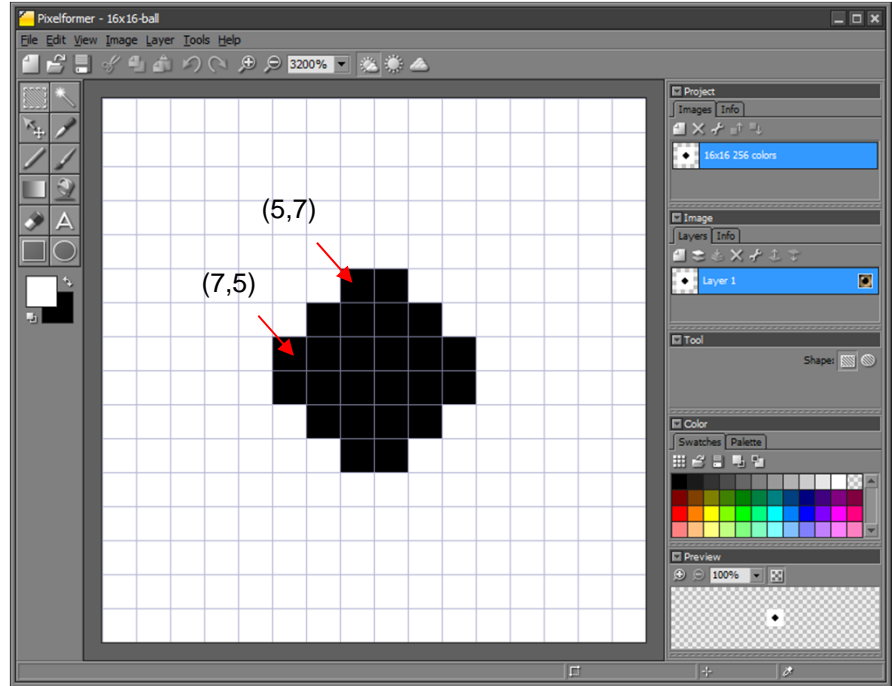
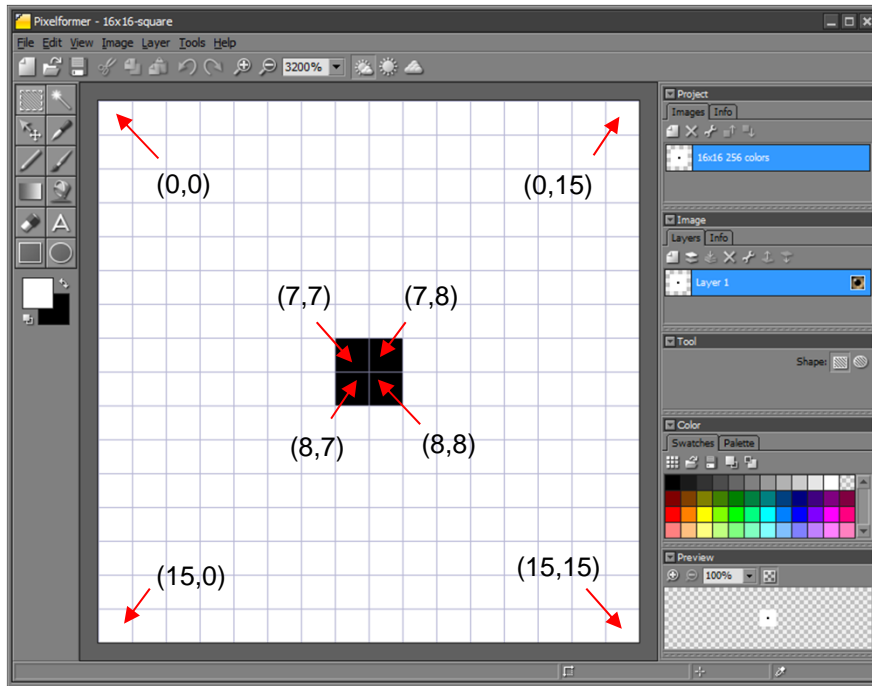


Image Processing: Areas and Centroids



Q1. What is the image's area spanned by the black pixel?

A1. Area is defined as the number of specific (e.g. black) pixels contained within an object in an image

In this simple 16x16 image, the black square is easily identified as the object. Thus, intuitively, the area = 4.

Using the definition of area, the above has an area of 24 (black pixels).

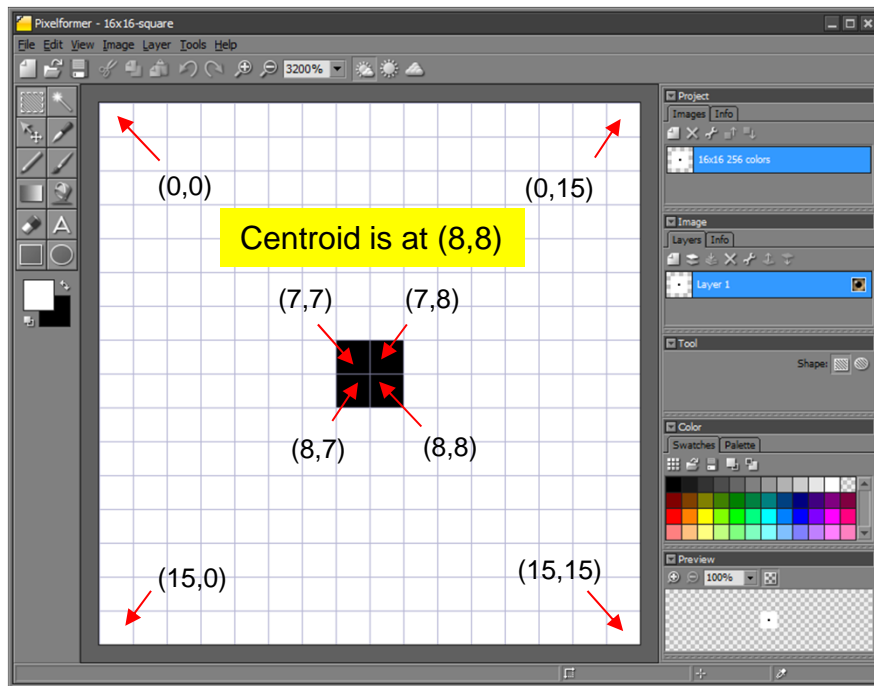
```
int area(struct Image *In, int x1, int y1,
        int x2, int y2, unsigned char ObjVal) {

    long i, j;
    int area_value = 0;

    for(i=x1; i <= x2; ++i)
        for(j=y1; j <= y2; ++j) {
            if(pix(In, i, j)==ObjVal) ++area_value;
        }
    return(area_value);
}
```

Q2. What is the black image's centroid?

Centroid is the center of the image calculated by $X_c = \frac{1}{A} \sum_{i=1}^N X$ and $Y_c = \frac{1}{A} \sum_{i=1}^N Y$ where X_c and Y_c are the centroid coordinates, X and Y are the i th pixel's coordinates, and A is the area of the object.



$$X_c = \frac{1}{A} \sum_{i=1}^N X = \frac{1}{4} \sum_{i=1}^4 X = \frac{1}{4} (7 + 8 + 7 + 8) = 7.5$$

$$Y_c = \frac{1}{A} \sum_{i=1}^N Y = \frac{1}{4} \sum_{i=1}^4 Y = \frac{1}{4} (7 + 8 + 7 + 8) = 7.5$$

```
void *centroid(struct Image *In, int x1,
              int y1, int x2, int y2,
              unsigned char ObjVal,
              struct coord *coords) {
    long i, j;
    int area_value, Xcent = 0, Ycent = 0;

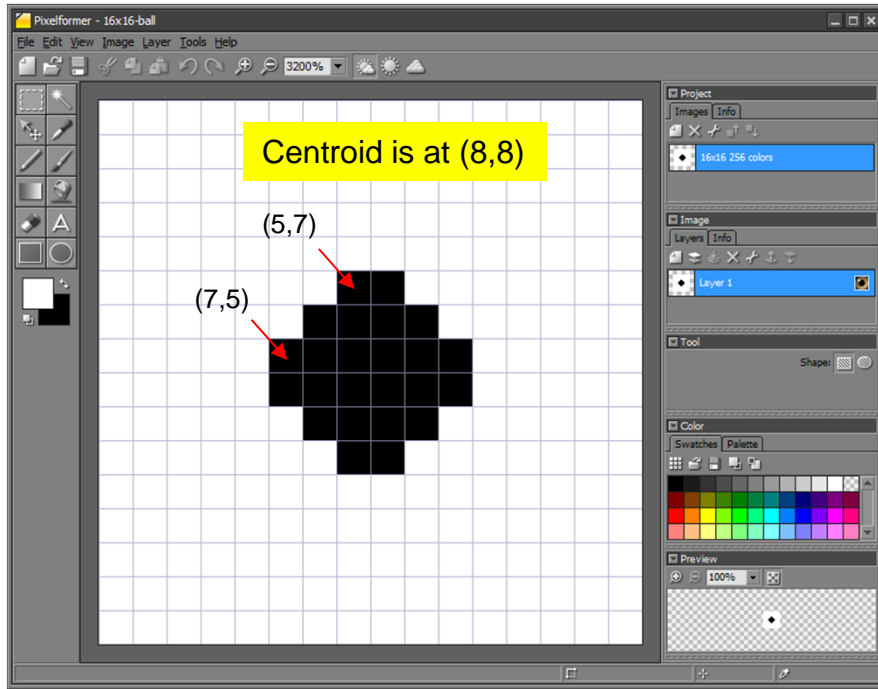
    area_value = area(In, x1, y1, x2, y2, ObjVal);

    if(area_value == 0) {
        coords->x = -1; coords->y = -1;
        return 0;
    };

    for(i=x1; i<=x2; ++i)
        for(j=y1; j<=y2; ++j) {
            if(pix(In, i, j) == ObjVal) {
                Xcent += j;
                Ycent += i;
            }
        }

    coords->x = Xcent/area_value + 1;
    coords->y = Ycent/area_value + 1;

    return 0;
} // end function centroid
```



$$X_c = \frac{1}{A} \sum_{i=1}^N X = \frac{1}{24} \sum_{i=1}^{24} X = \frac{1}{24} (5 * 2 + 6 * 4 + 7 * 6 + 8 * 6 + 9 * 4 + 10 * 2) = \frac{1}{24} (10 + 24 + 42 + 48 + 36 + 20) = \frac{180}{24} = 7.5$$

$$Y_c = \frac{1}{A} \sum_{i=1}^N Y = \frac{1}{24} \sum_{i=1}^{24} Y = \frac{1}{24} (5 * 2 + 6 * 4 + 7 * 6 + 8 * 6 + 9 * 4 + 10 * 2) = \frac{1}{24} (10 + 24 + 42 + 48 + 36 + 20) = 7.5$$