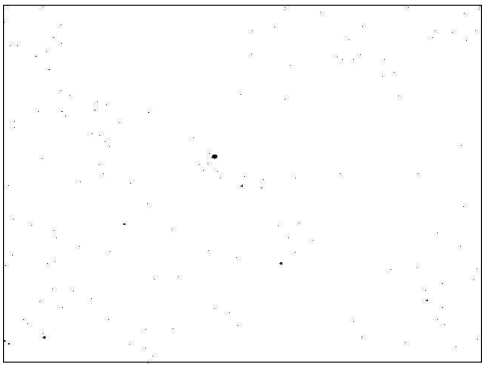
Multimedia Programming

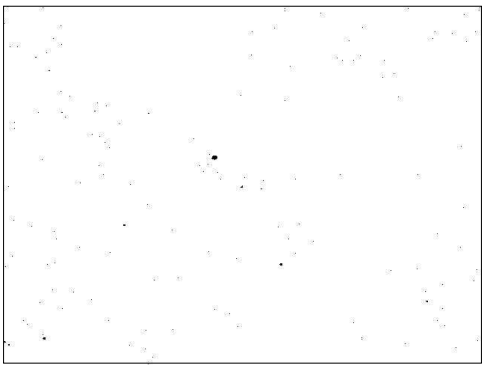
Counting Stars

Problem: how many stars are in this image?

Converted to black and white



Converted to black and white



How many black blobs?

A "blob" is a group of adjacent pixels

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Decide that "adjacent" means 4-way, not 8-way

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Want to count each blob once

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Scan the image left to right, top to bottom

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Scan the image left to right, top to bottom

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But how do we tell?

Turn black pixels red

A "blob" is a group of adjacent pixels

Decide that "adjacent" means 4-way, not 8-way

Want to count each blob once

Scan the image left to right, top to bottom

Increment count each time we find a new blob

But how do we tell?

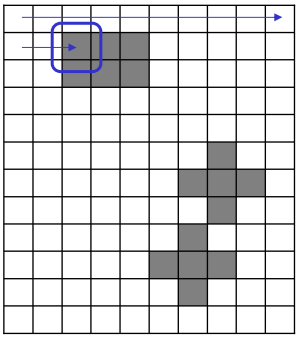
Turn black pixels red

If there is a red pixel before this one in scan order,

we have already counted this blob

Scan to black pixel

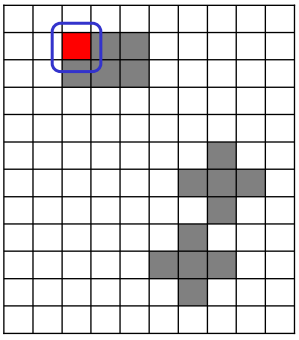
`count: 0`



Scan to black pixel

Mark it seen

`count: 0`



Scan to black pixel

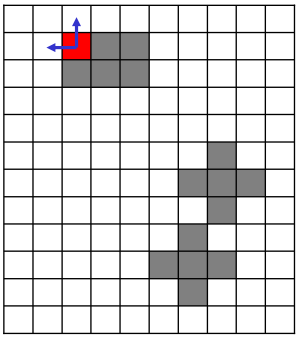
Mark it seen

Nothing red ahead of it

in scan order, so it must be

a new star

```
count: 1
```

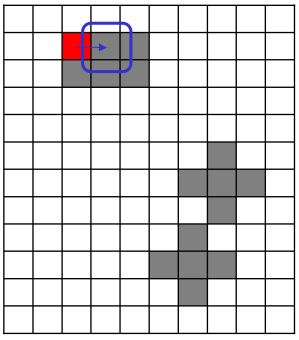


Scan to black pixel

Mark it seen

Keep scanning

```
count: 1
```



Scan to black pixel

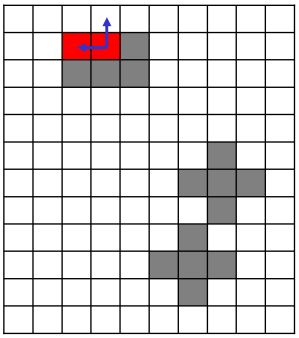
Mark it seen

Keep scanning

Does have red predecessor,

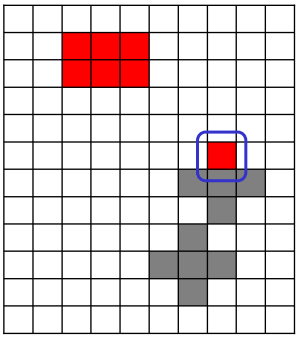
so this star already counted

`count: 1`



A new star!

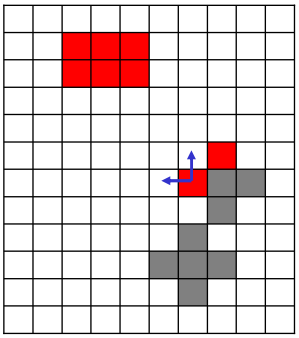
`count: 2`



A new star!

But this looks like a new star as well...

```
count: 2
```



A new star!

But this looks like a new star as well...

So look in more directions

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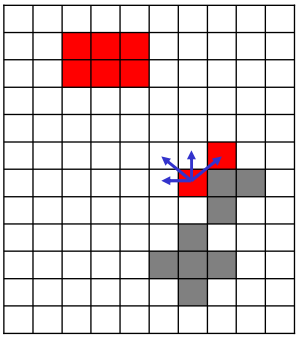
count: 2
```



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But this looks like a new star as well...

So look in more directions

But this also gives the wrong answer

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count: 2
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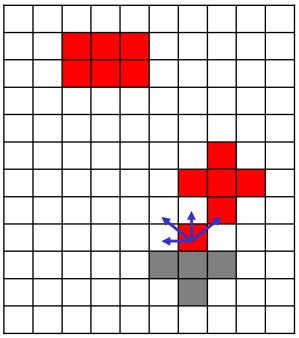


A new star!

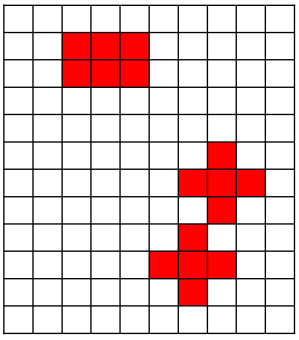
But this looks like a new star as well...

So look in more directions

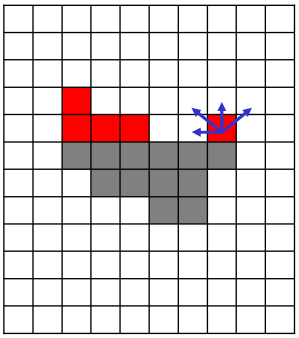
But this also gives the wrong answer

Change our definition so that these two blobs are one star?

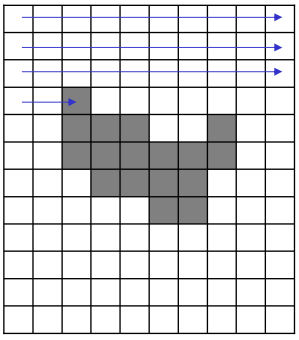
```
count: 2
```



Still gives the wrong answer

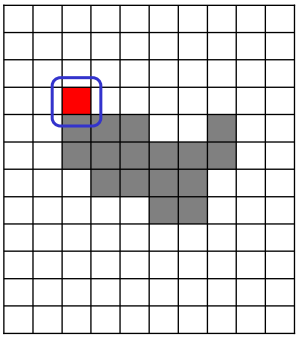


Solution: use *flood fill* to color in each star when it is first encountered



Solution: use *flood fill* to color in each star when it is first encountered

Find an uncolored pixel



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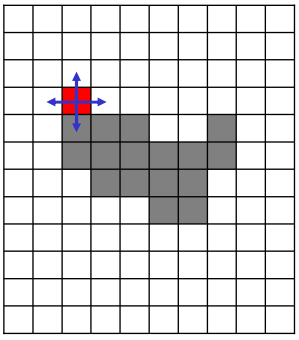
Find an uncolored pixel

Look at its neighbors

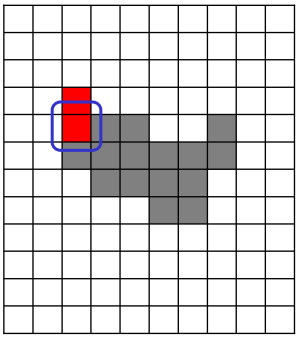


Solution: use *flood fill* to color in each star when it is first encountered

Find an uncolored pixel

Look at its neighbors

For each that needs coloring...



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Look at its neighbors

For each that needs coloring...

Look at its neighbors, and

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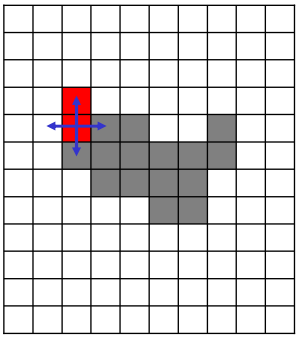

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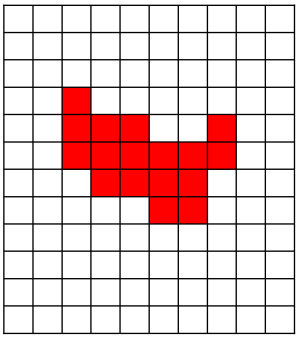
Stop when whole star colored



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Find an uncolored pixel

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For each that needs coloring...

Look at its neighbors, and

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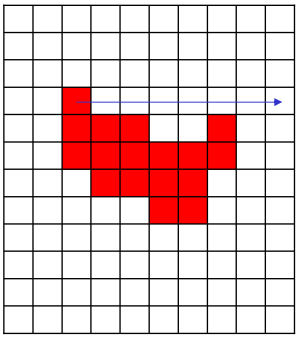
Stop when whole star colored

Then start scanning again



```
def count(picture):
  xsize, ysize = picture.size
  temp = picture.load()
  result = 0
  for x in range(xsize):
    for y in range(ysize):
      if temp[x, y] == BLACK:
        result += 1
        fill(temp, xsize, ysize, x, y)
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Keep list of (x, y) coordinates to be examined

Loop until queue is empty:

- Take (x, y) coordinates from queue
- If black, fill it in and add neighbors to queue


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def fill(pic, xsize, ysize, x_start, y_start):
  queue = [(x_start, y_start)]
  while queue:
    x, y, queue = queue[0][0], queue[0][1], queue[1:]
    if pic[x, y] == BLACK:
      pic[x, y] = RED
      if x > 0:           queue.append((x-1, y))
      if x < (xsize-1):   queue.append((x+1, y))
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Filling in action

```
[(1, 2)]
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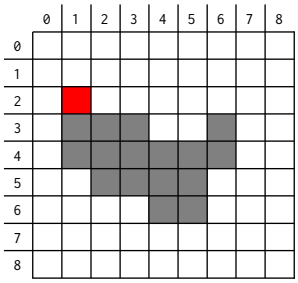
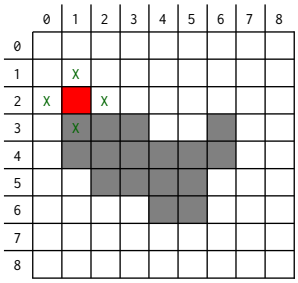


Filling in action

```
[(0, 2),
 (2, 2),
 (1, 1),
 (1, 3)]
```



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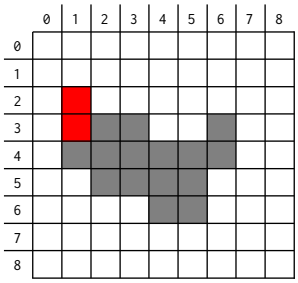
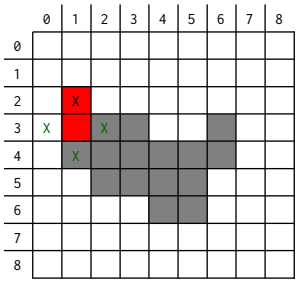


Filling in action

```
[(1, 2),
 (0, 3),
 (2, 3),
 (1, 4)]
```



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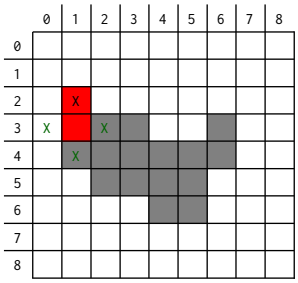

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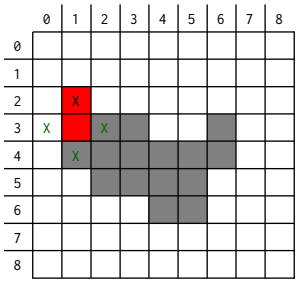

Exercise: never look at a pixel twice

Or use a *recursive* algorithm

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Keep the work to be done on the call stack

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def fill(pic, xsize, ysize, x, y):
  if pic[x, y] != BLACK:
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  if x > 0:          fill(pic, xsize, ysize, x-1, y)
  if x < (xsize-1):  fill(pic, xsize, ysize, x+1, y)
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```


Call stack holds pixels currently being examined

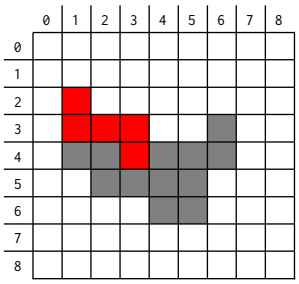
most recent call → `fill(..., 3, 4)`

`fill(..., 3, 3)`

`fill(..., 2, 3)`

`fill(..., 1, 3)`

first call → `fill(..., 1, 2)`



created by

Paul Gries, Jeremy Nickurak, and Greg Wilson

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