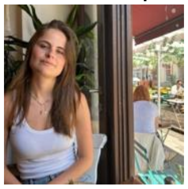
Neta Nakdimon
322216128
BS.c Computer Science



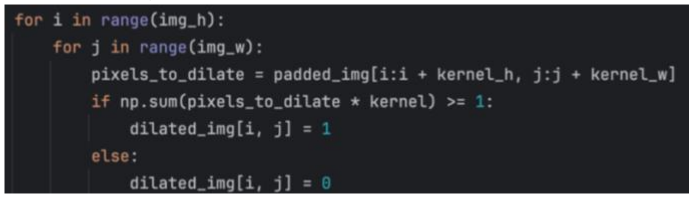
Basic Image Processing – Ex2

Part 1

i. My_dilate:

There are three main steps in my code:

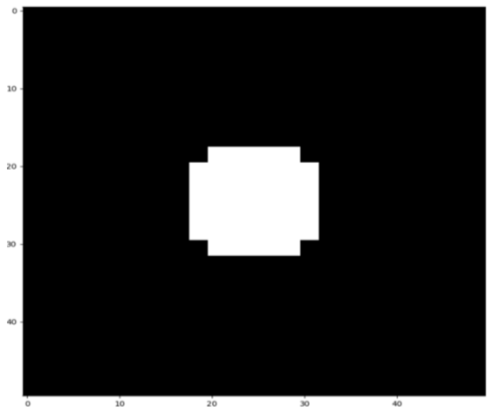
1. Initializing an output image matching the size of the original input(img) which will store the final dilated result.
2. Constructing a padded version of img. I used it to ensure the kernel can be applied even at the edges of the image without exceeding the bounds. (padding with 0's).
3. I used two nested for loops to iterate each pixel of the padded image. For each position the actions are:
    a. Extracting the section of the padded image that corresponds to the kernel's current location.
    b. Performing element wise multiplication between the kernel and the selected section. Both arrays only contain 0's and 1's this step check if the kernel overlaps with any non-zero values.
    c. If the result contains at least one non-zero value, update the corresponding position in the output image to 1(as seen in class). Otherwise, set it to 0.



```
for i in range(img_h):
    for j in range(img_w):
        pixels_to_dilate = padded_img[i:i + kernel_h, j:j + kernel_w]
        if np.sum(pixels_to_dilate * kernel) >= 1:
            dilated_img[i, j] = 1
        else:
            dilated_img[i, j] = 0
```

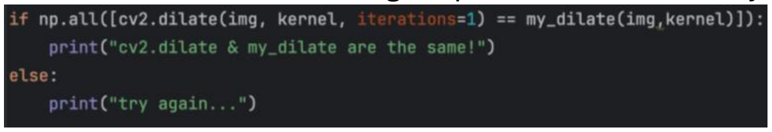
I referred the kernel as a "shape" that expands the white regions in the image.

The image after running my_dilate:



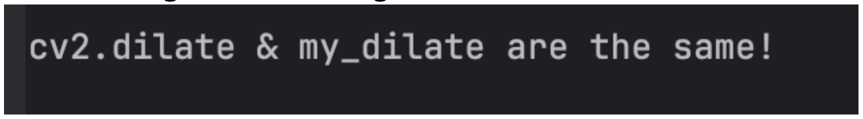
ii. <u>Comparing my_dilate to cv2.dilate</u>:

I used np.all to compare each pixel in the output of both cv2.dilate and my_dilate functions. If all the pixels match exactly, meaning the results are identical - a success message is printed. Otherwise, try again is printed.



```
if np.all([cv2.dilate(img, kernel, iterations=1) == my_dilate(img,kernel)]):
    print("cv2.dilate & my_dilate are the same!")
else:
    print("try again...")
```

The result I got after running it:



```
cv2.dilate & my_dilate are the same!
```

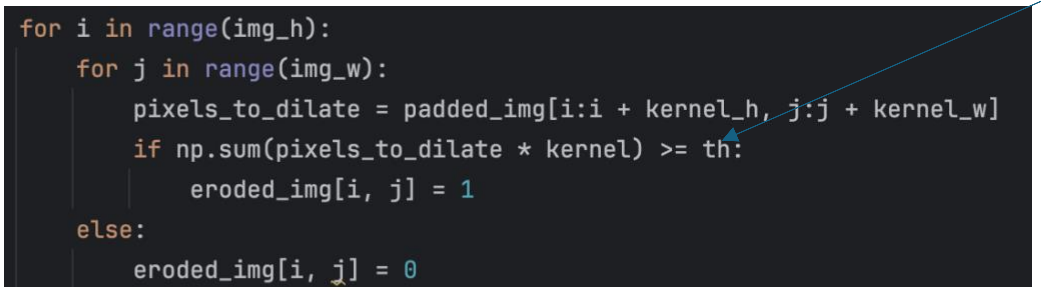
iii. <u>My_erode:</u>

The main ideas here are the same as in my_dilate. The main difference is in the condition inside the for loop- as seen in class, when eroding we check if the sum of multiplying the kernel with the relevant section of interest is bigger or equals to the sum of the kernel. I will now describe the steps in my code expressing the differences from my_dilate.

1. Initializing an output image matching the size of the original input(img) which will store the final eroded result.
2. Constructing a padded version of img. I used it to ensure the kernel can be applied even at the edges of the image without exceeding the bounds. Here the padding is with 1's – this ensures areas outside the original image are treated as white, which fits the erosion logic.
3. I used two nested for loops to iterate each pixel of the padded image. For each position the actions are:
    a. Extracting the section of the padded image that corresponds to the kernel's current location.
    b. Performing element wise multiplication between the kernel and the selected section. Both arrays only contain 0's and 1's this step check if the kernel overlaps with any non-zero values.

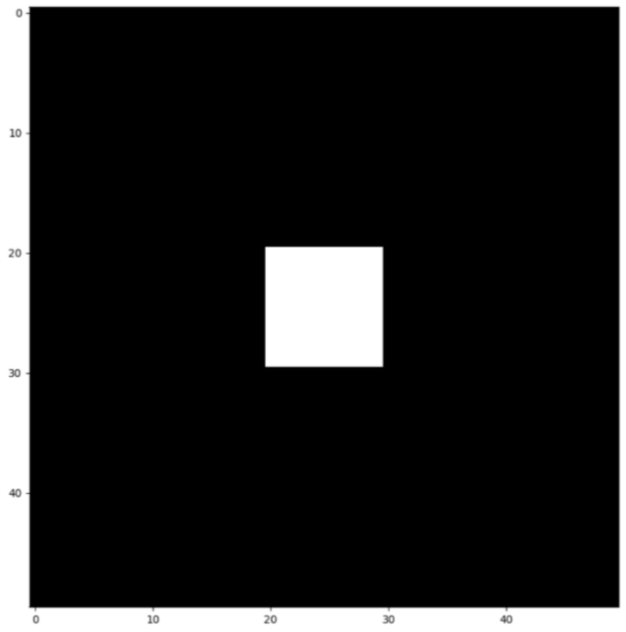
c. Checking if the sum of the result is bigger or equal to the kernel's total sum – meaning the kernel fits entirely within a white region. If true, setting the output pixel to 1, Otherwise 0.

th is kernel.sum

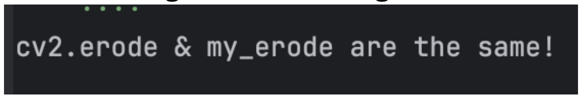


```
for i in range(img_h):
    for j in range(img_w):
        pixels_to_dilate = padded_img[i:i + kernel_h, j:j + kernel_w]
        if np.sum(pixels_to_dilate * kernel) >= th:
            eroded_img[i, j] = 1
    else:
        eroded_img[i, j] = 0
```

The image after running my_erode:



iv. <u>Comparing my_erode to cv2.erode</u>:
I used np.all to compare each pixel in the output of both cv2.erode and my_erode functions. If all the pixels match exactly, meaning the results are identical - a success message is printed. Otherwise, try again is printed.
The result I got after running it:

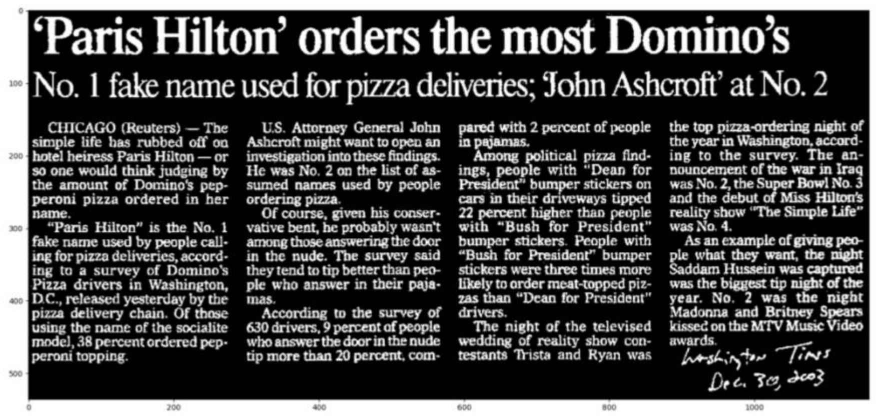


```
cv2.erode & my_erode are the same!
```

Part 2

i. <u>Turning the image to a binary one:</u>
To simplify the processing, the image is converted to a binary format (0 for black and 255 for white).
Threshold Value – I started with using a threshold of 127(I've read online that this is standard value, and saw it doesn't show the image very well, so I changed it a few times till I found that with a value of 180 the image is optimal visually). All pixel values greater than this are turned into black (0) and the rest into white (255).
Threshold Type – I read about the different thresholds of cv2 and found that cv2.THRESH_BINARY_INV is used to invert the binary image making the objects white and the background black. As seen in class, this setup aligns better with the kernel operations used for morphological processes.

The image after turning it into a binary format:



'Paris Hilton' orders the most Domino's

No. 1 fake name used for pizza deliveries; 'John Ashcroft' at No. 2

CHICAGO (Reuters) — The simple life has rubbed off on hotel heiress Paris Hilton — or so one would think judging by the amount of Domino's pepperoni pizza ordered in her name.

"Paris Hilton" is the No. 1 fake name used by people calling for pizza deliveries, according to a survey of Domino's Pizza drivers in Washington, D.C., released yesterday by the pizza delivery chain. Of those using the name of the socialite model, 38 percent ordered pepperoni topping.

U.S. Attorney General John Ashcroft might want to open an investigation into these findings. He was No. 2 on the list of assumed names used by people ordering pizza.

Of course, given his conservative bent, he probably wasn't among those answering the door in the nude. The survey said they tend to tip better than people who answer in their pajamas.

According to the survey of 630 drivers, 9 percent of people who answer the door in the nude tip more than 20 percent, compared with 2 percent of people in pajamas.

Among political pizza findings, people with "Dean for President" bumper stickers on cars in their driveways tipped 22 percent higher than people with "Bush for President" bumper stickers. People with "Bush for President" bumper stickers were three times more likely to order meat-topped pizzas than "Dean for President" drivers.

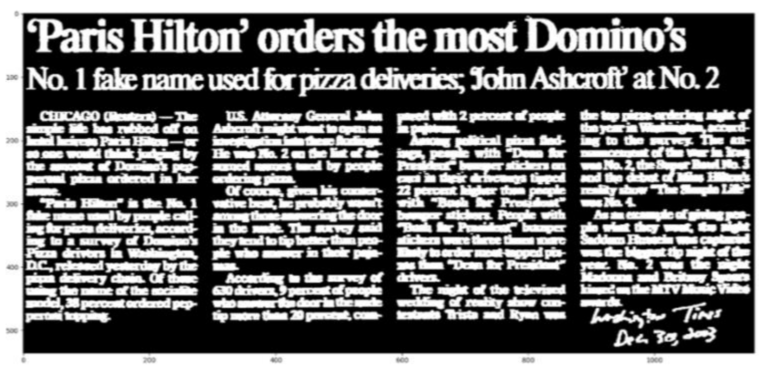
The night of the televised wedding of reality show contestants Trista and Ryan was the top pizza-ordering night of the year in Washington, according to the survey. The announcement of the war in Iraq was No. 2, the Super Bowl No. 3 and the debut of Miss Hilton's reality show "The Simple Life" was No. 4.

As an example of giving people what they want, the night Saddam Hussein was captured was the biggest tip night of the year. No. 2 was the night Madonna and Britney Spears kissed on the MTV Music Video awards.

Washington Times
Dec. 30, 2003

ii. <u>Merging all pixels of the same word together to make one connected component using a morphologic operator:</u>
Kernel definition - I defined a rectangular kernel using cv2.getStructuringElement with dimensions (4, 2). This shape and dimensions were selected after trial and error, as it effectively merges horizontal components (like the letters in a word).
Dilation application – With the defined kernel, I applied the cv2.dilate function. The dilation "grows" the white regions in the binary image, bridging gaps between close pixels to form a single connected component.
Result – The processed image shows letters for each word connected seamlessly, creating a unified structure. This step is crucial to prevent merging unrelated letters.

The image after running the code:



'Paris Hilton' orders the most Domino's

No. 1 fake name used for pizza deliveries; 'John Ashcroft' at No. 2

CHICAGO (Reuters) — The simple life has rubbed off on hotel heiress Paris Hilton — or so one would think judging by the amount of Domino's pepperoni pizza ordered in her name.

"Paris Hilton" is the No. 1 fake name used by people calling for pizza deliveries, according to a survey of Domino's Pizza drivers in Washington, D.C., released yesterday by the pizza delivery chain. Of those using the name of the socialite model, 38 percent ordered pepperoni topping.

U.S. Attorney General John Ashcroft might want to open an investigation into these findings. He was No. 2 on the list of assumed names used by people ordering pizza.

Of course, given his conservative bent, he probably wasn't among those answering the door in the nude. The survey said they tend to tip better than people who answer in their pajamas.

According to the survey of 630 drivers, 9 percent of people who answer the door in the nude tip more than 20 percent, compared with 2 percent of people in pajamas.

Among political pizza findings, people with "Dean for President" bumper stickers on cars in their driveways tipped 22 percent higher than people with "Bush for President" bumper stickers. People with "Bush for President" bumper stickers were three times more likely to order meat-topped pizzas than "Dean for President" drivers.

The night of the televised wedding of reality show contestants Trista and Ryan was the top pizza-ordering night of the year in Washington, according to the survey. The announcement of the war in Iraq was No. 2, the Super Bowl No. 3 and the debut of Miss Hilton's reality show "The Simple Life" was No. 4.

As an example of giving people what they want, the night Saddam Hussein was captured was the biggest tip night of the year. No. 2 was the night Madonna and Britney Spears kissed on the MTV Music Video awards.

Washington Times
Dec 30, 2003

iii. Find Words Method:
This method processes the image and outline each word by drawing rectangles around them (using the provided draw method).
The main steps of my code:

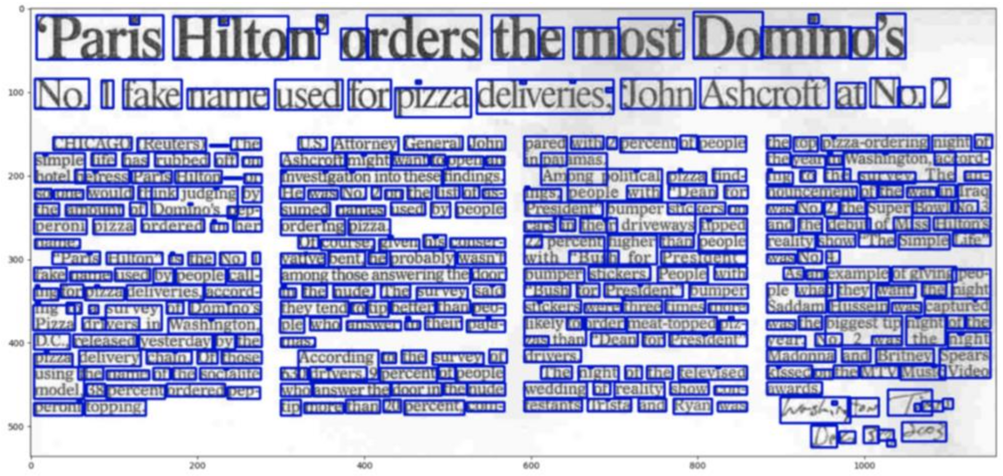
a. Finding connected components:
I used cv2.connectedComponentWithStats function to detect connected components in the binary image. It identifies groups of connected white pixels and provides their properties, including:
   - Number of components
   - Bounding box information for each component (x, y, w, h)
b. Iterating through components:
For each connected component (ignoring the background) extracting the bounding box coordinates to determine the region of the component.
c. Creating a mask for the component:
Mask for the specific bounding box to isolate the detected word.
d. Drawing rectangles:
Using plot_rec to draw rectangles around each detected word on the result image.

The output is not perfect at all (as can be seen in the picture). This could be a result of a few different things:

- **Kernel size** - The size and shape of the kernel may not suit all text structures. For instance, a rectangular kernel might work well for horizontally aligned text but may fail for irregular shapes or smaller text sizes.
- **Image quality and complexity** - Variations in the original image, such as noise, low resolution, or mixed content like the handwritten signature, can interfere with consistent detection. A single kernel shape as I used might not adapt well to these variations.

- **Thresholding and binary conversion** - Errors in the thresholding step, such as setting an inappropriate threshold value, could introduce noise or artifacts. This noise impacts the accuracy of connected components and subsequent dilation/erosion steps. The threshold I used gives the best result I could get to.

The image after running find_words:



'Paris Hilton' orders the most Domino's

No. 1 fake name used for pizza deliveries; 'John Ashcroft' at No. 2

CHICAGO (Reuters) — The simple life has rubbed off on hotel heiress Paris Hilton — or so one would think judging by the amount of Domino's pepperoni pizza ordered in her name.

"Paris Hilton" is the No. 1 fake name used by people calling for pizza deliveries, according to a survey of Domino's Pizza drivers in Washington, D.C., released yesterday by the pizza delivery chain. Of those using the name of the socialite model, 68 percent ordered pepperoni topping.

U.S. Attorney General John Ashcroft might want to open an investigation into these findings. He was No. 2 on the list of assumed names used by people ordering pizza.

Of course, given his conservative bent, he probably wasn't among those answering the door in the nude. The survey said they tend to tip better than people who answer in their pajamas.

According to the survey of 531 drivers, 9 percent of people who answer the door in the nude tip more than 20 percent, compared with 2 percent of people in pajamas.

Among political pizza findings, people with "Dean for President" bumper stickers on cars in their driveways tipped 22 percent higher than people with "Bush for President" bumper stickers. People with "Bush for President" bumper stickers were three times more likely to order meat-topped pizzas than "Dean for President" drivers.

The night of the televised wedding of reality show contestants Trista and Ryan was the top pizza-ordering night of the year in Washington, according to the survey. The announcement of the war in Iraq was No. 2, the Super Bowl No. 3 and the debut of Miss Hilton's reality show "The Simple Life" was No. 4.

As an example of giving people what they want, the night Saddam Hussein was captured was the biggest tip night of the year. No. 2 was the night Madonna and Britney Spears kissed on the MTV Music Video awards.

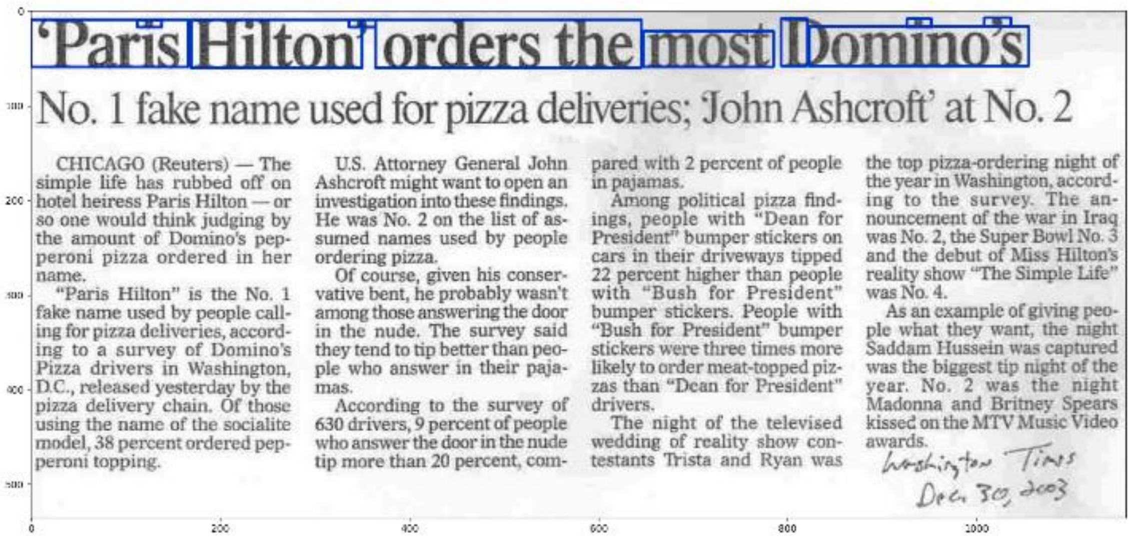
Washington Times
Dec 5th 2003

iv. <u>Mark only big title words:</u>

To isolate large title words, I used morphological operations to emphasize big components while ignoring smaller text. The steps are as follows:

a. **Erosion**: Applied with a square kernel (7×7 – found after trial and error) to reduce noise and separate closely connected text. This step shrinks components, leaving smaller text almost eliminated.
b. **Dilation**: Performed using a rectangular kernel (7×26 - found after trial and error) to merge fragmented parts of large title words. The kernel size ensures that smaller components remain unaffected, while larger ones are expanded.
c. **Result**: The final image contains only the emphasized large title words as connected components, which can be processed further. The choice of kernel size and a single iteration prevents over-expansion.

The final image:



'Paris Hilton' orders the most Domino's

No. 1 fake name used for pizza deliveries; 'John Ashcroft' at No. 2

CHICAGO (Reuters) — The simple life has rubbed off on hotel heiress Paris Hilton — or so one would think judging by the amount of Domino's pepperoni pizza ordered in her name.

"Paris Hilton" is the No. 1 fake name used by people calling for pizza deliveries, according to a survey of Domino's Pizza drivers in Washington, D.C., released yesterday by the pizza delivery chain. Of those using the name of the socialite model, 38 percent ordered pepperoni topping.

U.S. Attorney General John Ashcroft might want to open an investigation into these findings. He was No. 2 on the list of assumed names used by people ordering pizza.

Of course, given his conservative bent, he probably wasn't among those answering the door in the nude. The survey said they tend to tip better than people who answer in their pajamas.

According to the survey of 630 drivers, 9 percent of people who answer the door in the nude tip more than 20 percent, compared with 2 percent of people in pajamas.

Among political pizza findings, people with "Dean for President" bumper stickers on cars in their driveways tipped 22 percent higher than people with "Bush for President" bumper stickers. People with "Bush for President" bumper stickers were three times more likely to order meat-topped pizzas than "Dean for President" drivers.

The night of the televised wedding of reality show contestants Trista and Ryan was the top pizza-ordering night of the year in Washington, according to the survey. The announcement of the war in Iraq was No. 2, the Super Bowl No. 3 and the debut of Miss Hilton's reality show "The Simple Life" was No. 4.

As an example of giving people what they want, the night Saddam Hussein was captured was the biggest tip night of the year. No. 2 was the night Madonna and Britney Spears kissed on the MTV Music Video awards.

Washington Times
Dec. 30, 2003