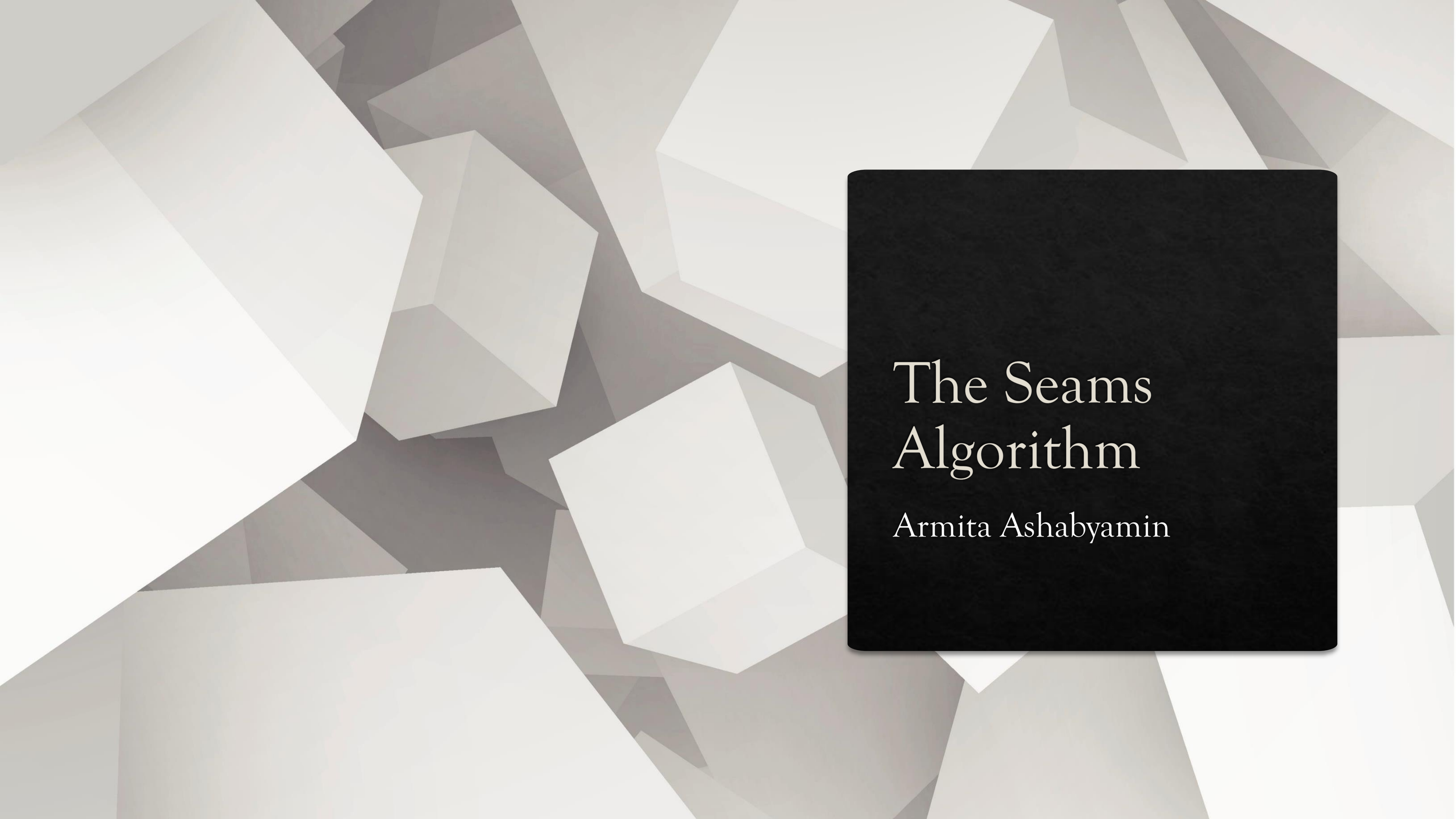
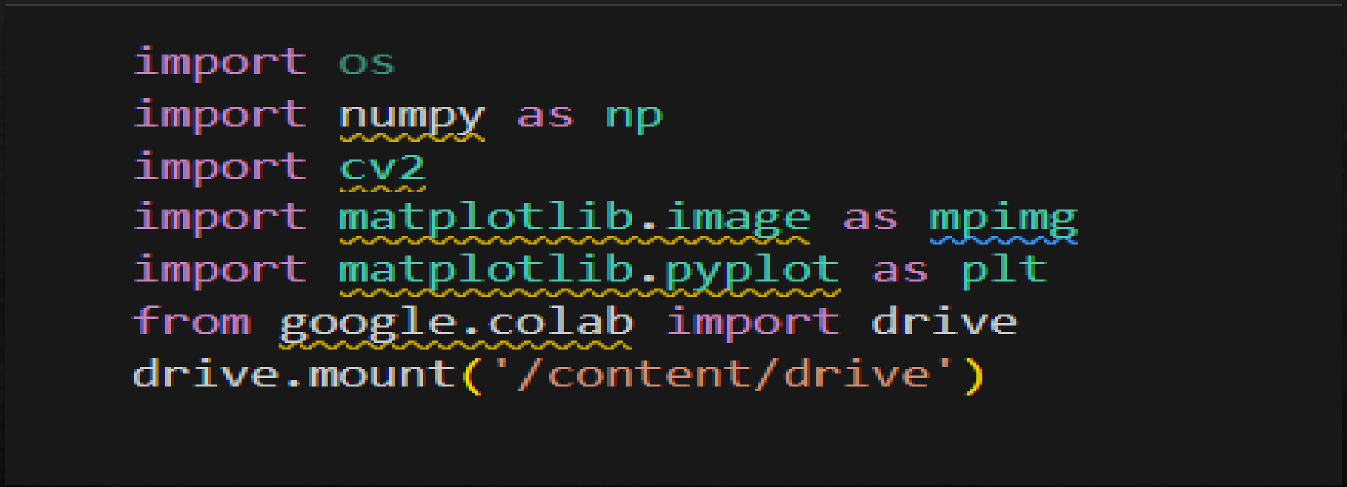


The Seams Algorithm

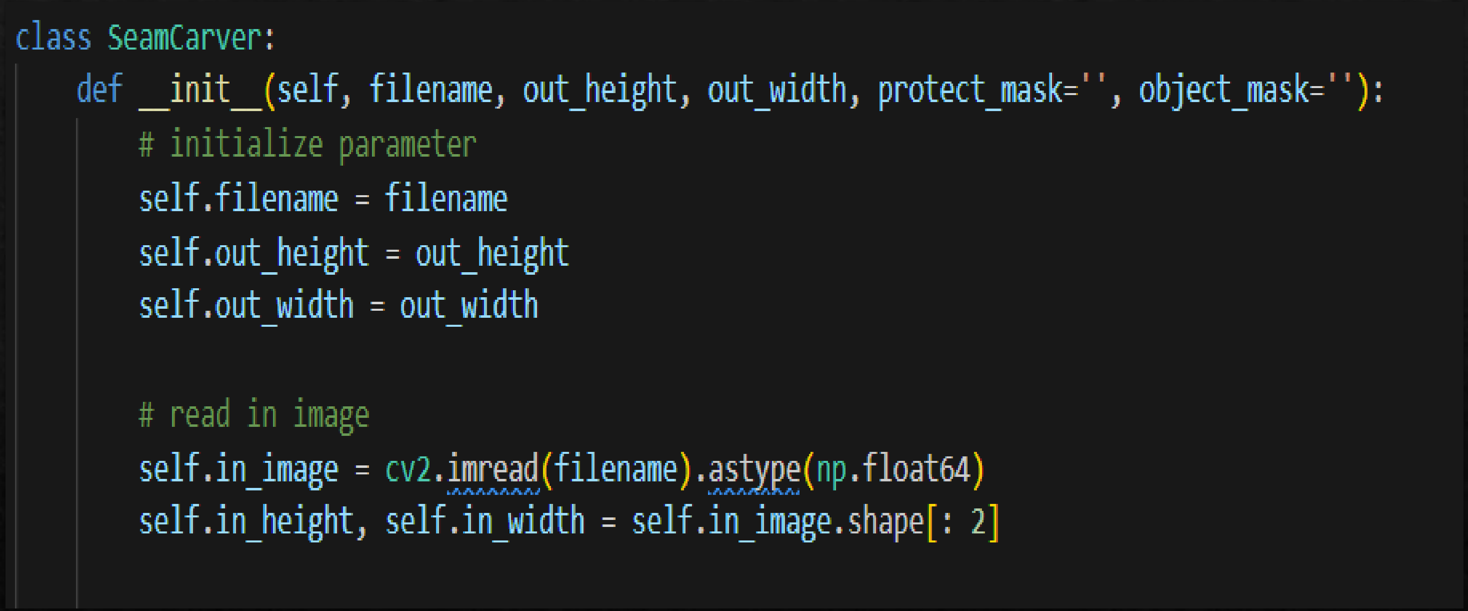
Armita Ashabyamin

We first import all of the libraries that we need:

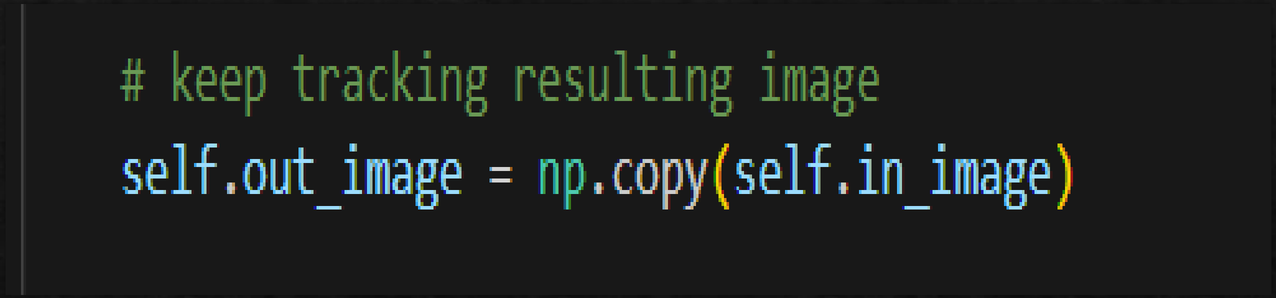


```python
import os
import numpy as np
import cv2
import matplotlib.image as mpimg
import matplotlib.pyplot as plt
from google.colab import drive
drive.mount('/content/drive')
```

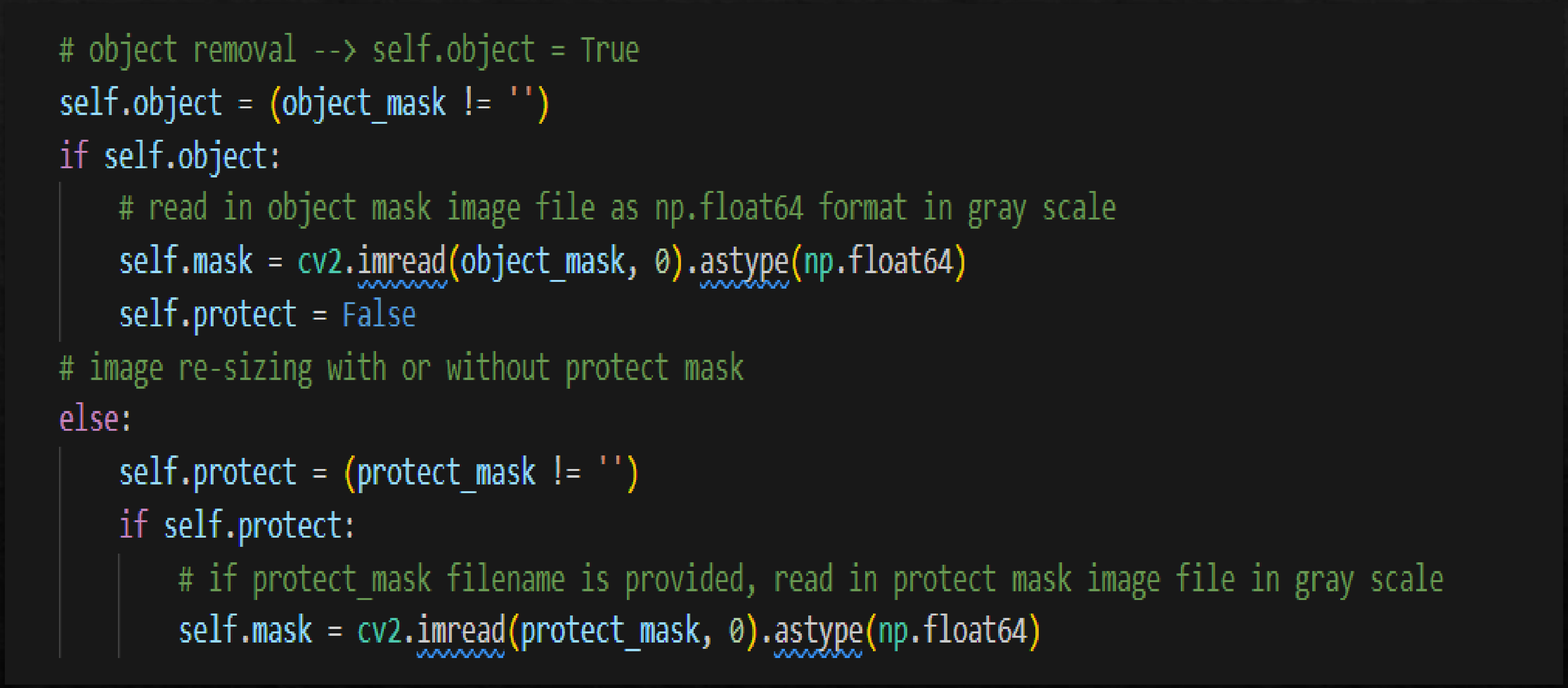
We then read our inputs and initialize our variables:



```
class SeamCarver:
    def __init__(self, filename, out_height, out_width, protect_mask='', object_mask=''):
        # initialize parameter
        self.filename = filename
        self.out_height = out_height
        self.out_width = out_width

        # read in image
        self.in_image = cv2.imread(filename).astype(np.float64)
        self.in_height, self.in_width = self.in_image.shape[: 2]
```

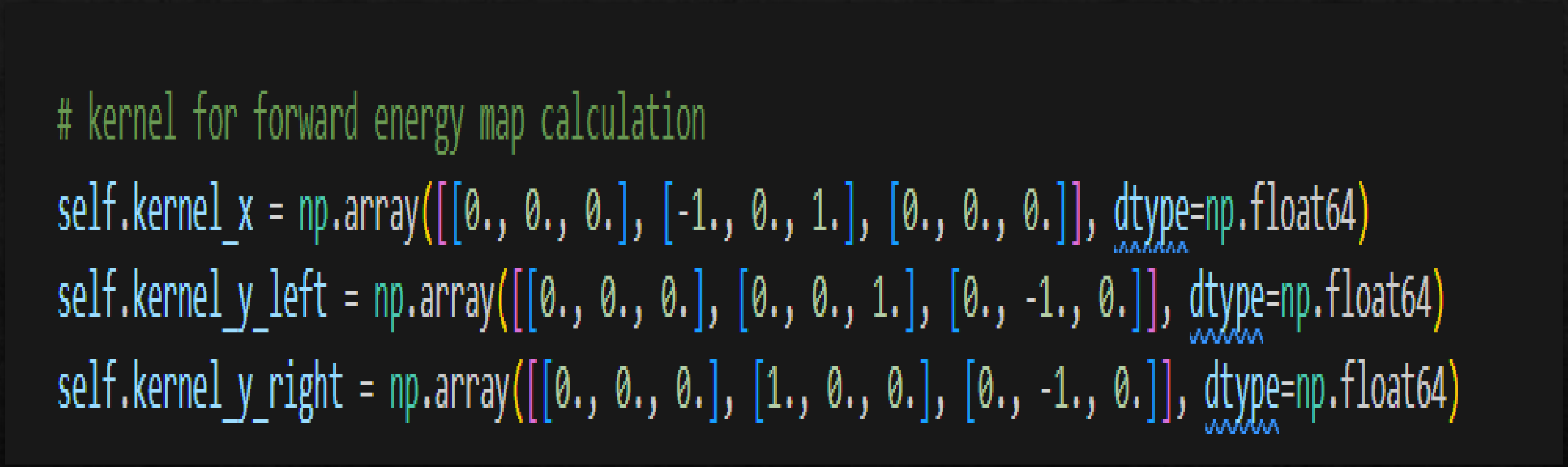


```
# keep tracking resulting image
self.out_image = np.copy(self.in_image)
```

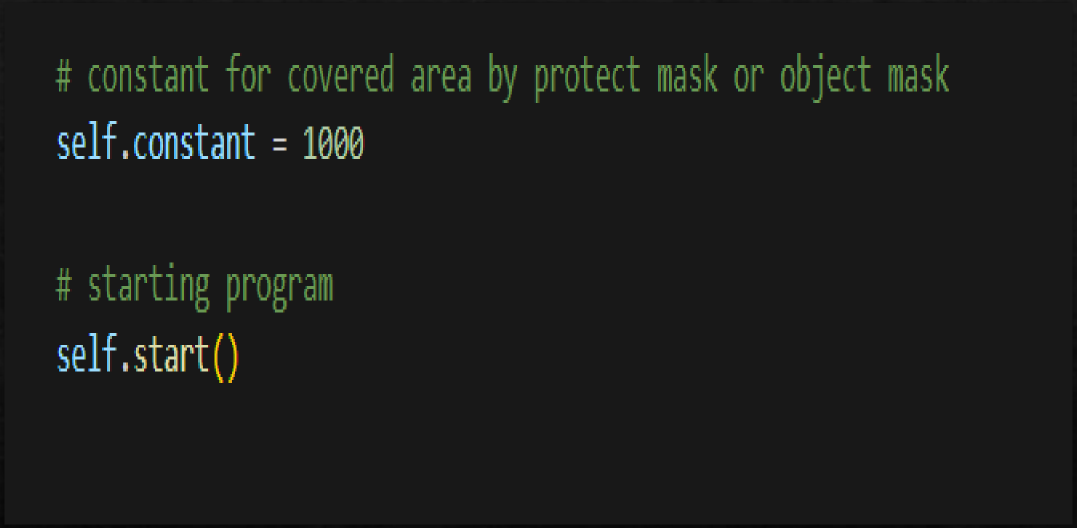


```
# object removal --> self.object = True
self.object = (object_mask != '')
if self.object:
    # read in object mask image file as np.float64 format in gray scale
    self.mask = cv2.imread(object_mask, 0).astype(np.float64)
    self.protect = False
# image re-sizing with or without protect mask
else:
    self.protect = (protect_mask != '')
    if self.protect:
        # if protect_mask filename is provided, read in protect mask image file in gray scale
        self.mask = cv2.imread(protect_mask, 0).astype(np.float64)
```

This is our kernel :

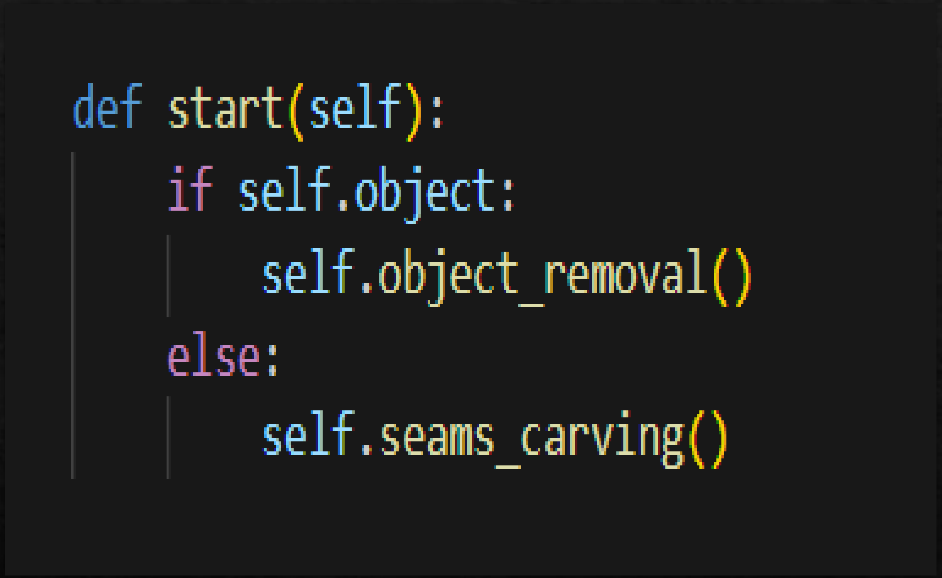


```
# kernel for forward energy map calculation
self.kernel_x = np.array([[0., 0., 0.], [-1., 0., 1.], [0., 0., 0.]], dtype=np.float64)
self.kernel_y_left = np.array([[0., 0., 0.], [0., 0., 1.], [0., -1., 0.]], dtype=np.float64)
self.kernel_y_right = np.array([[0., 0., 0.], [1., 0., 0.], [0., -1., 0.]], dtype=np.float64)
```

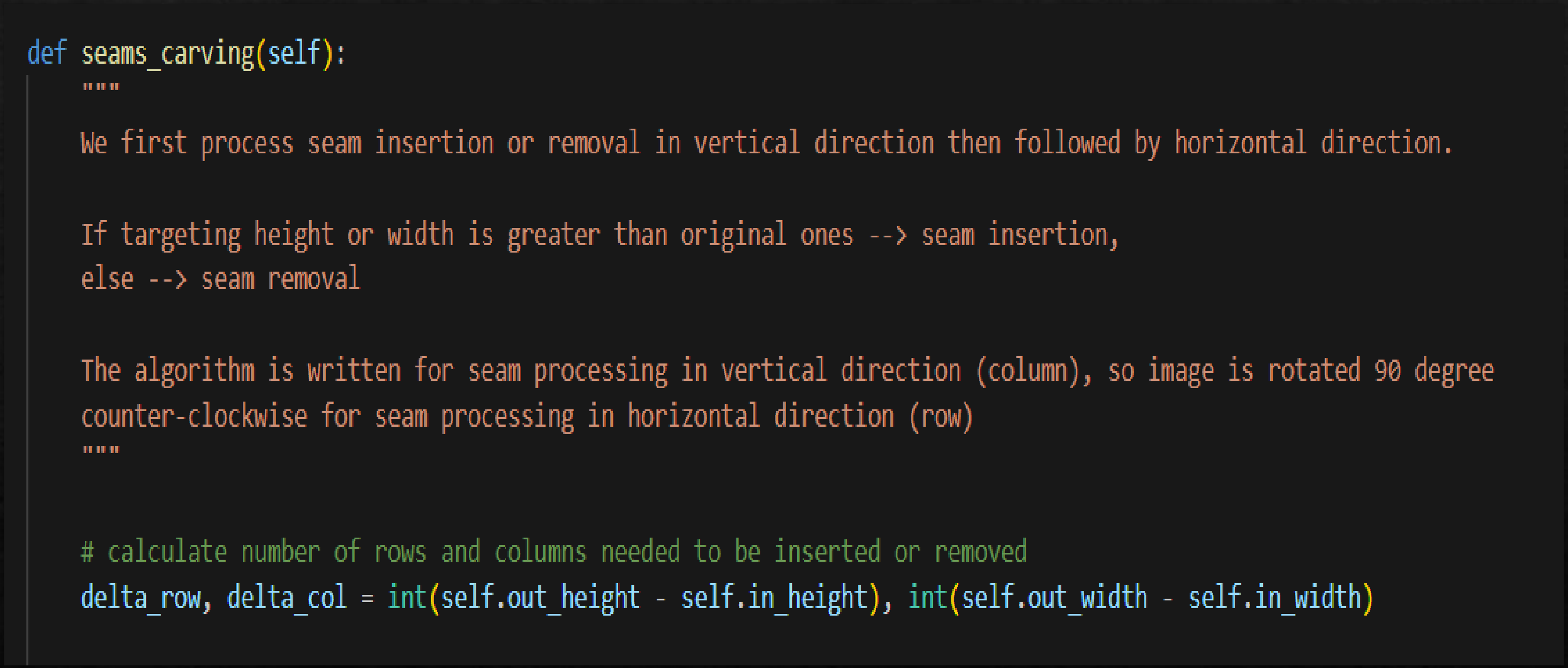


```
# constant for covered area by protect mask or object mask
self.constant = 1000

# starting program
self.start()
```

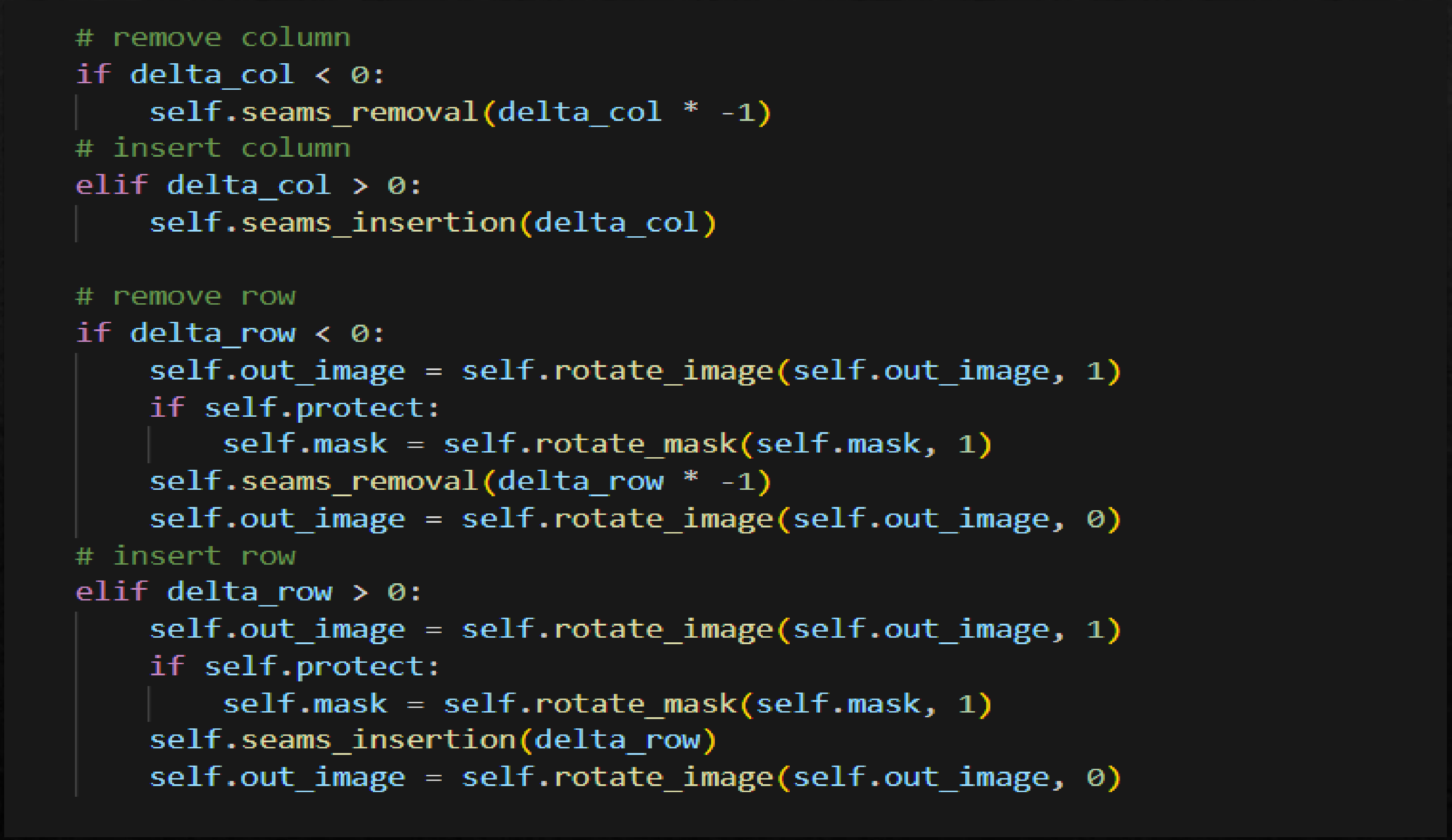
This is our start function that we called upon in the last slide:



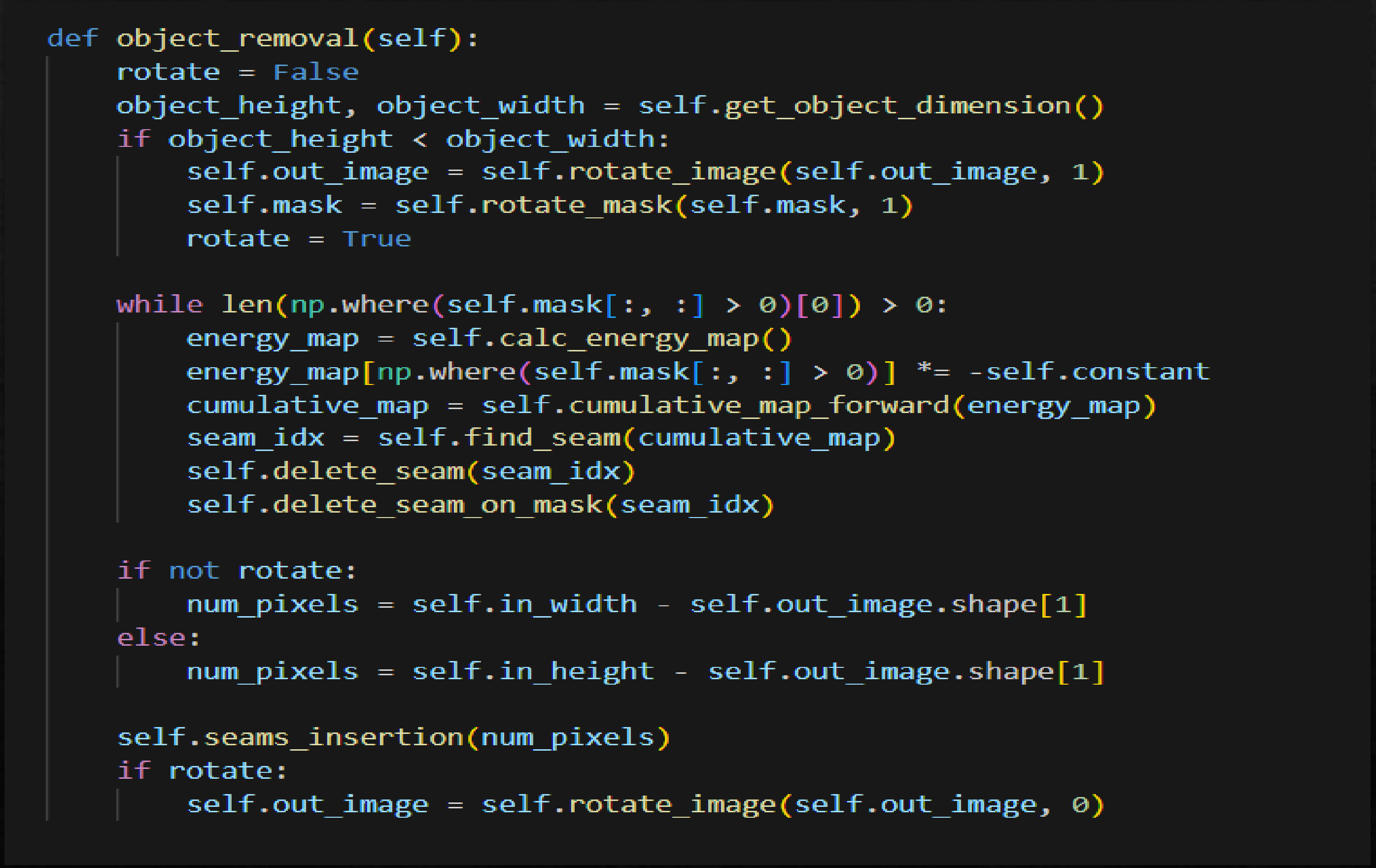
```
def start(self):
    if self.object:
        self.object_removal()
    else:
        self.seams_carving()
```



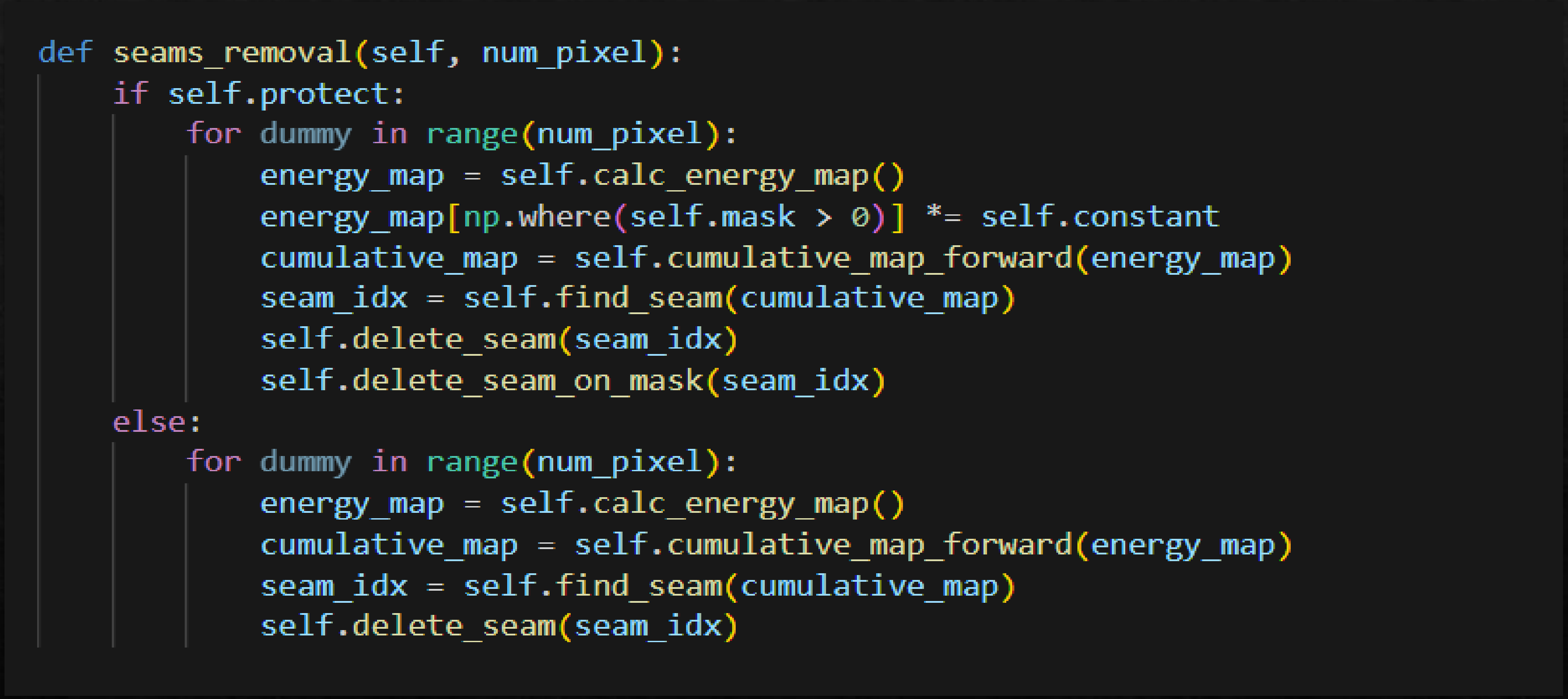
```python
def seams_carving(self):
    """
    We first process seam insertion or removal in vertical direction then followed by horizontal direction.

    If targeting height or width is greater than original ones --> seam insertion,
    else --> seam removal

    The algorithm is written for seam processing in vertical direction (column), so image is rotated 90 degree
    counter-clockwise for seam processing in horizontal direction (row)
    """

    # calculate number of rows and columns needed to be inserted or removed
    delta_row, delta_col = int(self.out_height - self.in_height), int(self.out_width - self.in_width)
```



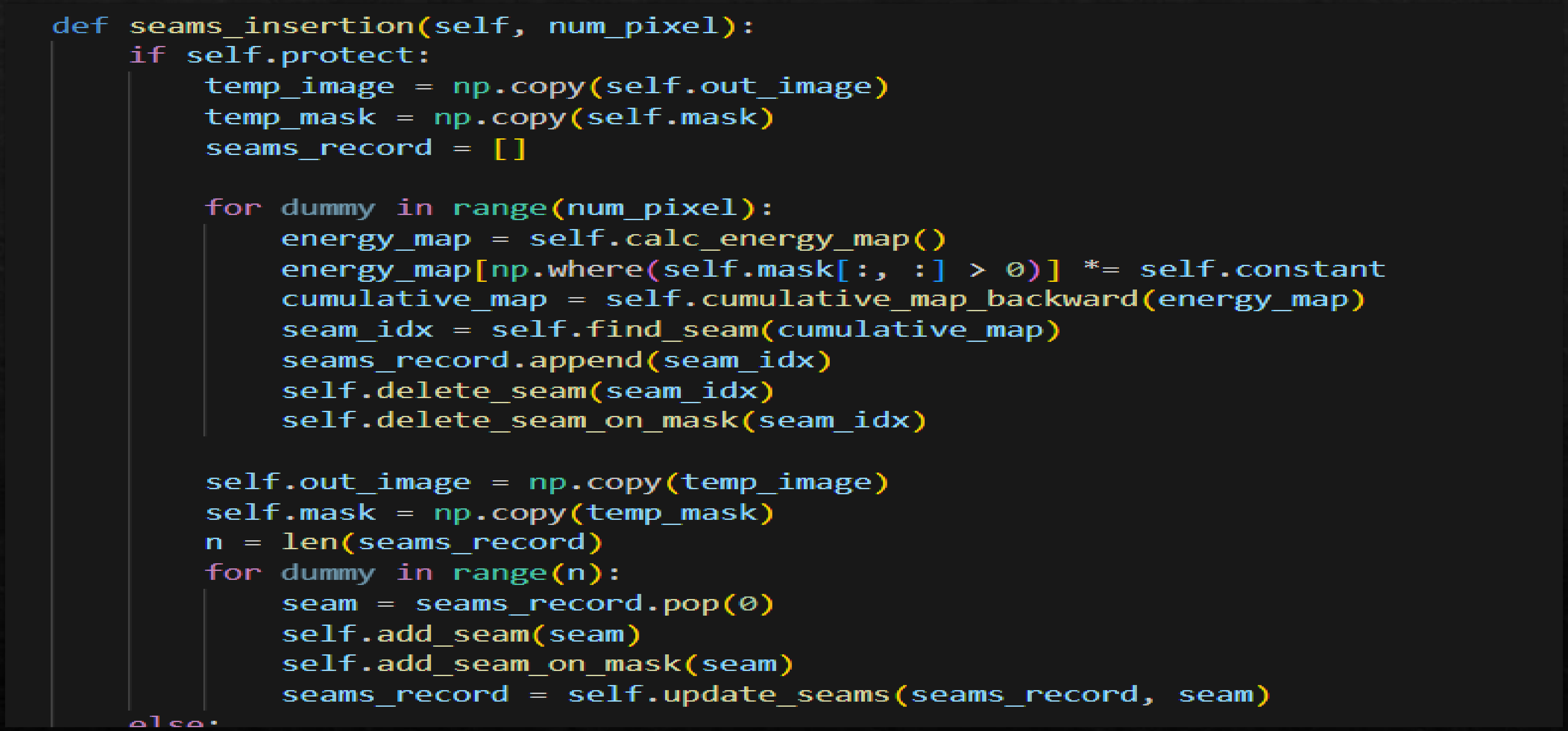
```
# remove column
if delta_col < 0:
    self.seams_removal(delta_col * -1)
# insert column
elif delta_col > 0:
    self.seams_insertion(delta_col)

# remove row
if delta_row < 0:
    self.out_image = self.rotate_image(self.out_image, 1)
    if self.protect:
        self.mask = self.rotate_mask(self.mask, 1)
    self.seams_removal(delta_row * -1)
    self.out_image = self.rotate_image(self.out_image, 0)
# insert row
elif delta_row > 0:
    self.out_image = self.rotate_image(self.out_image, 1)
    if self.protect:
        self.mask = self.rotate_mask(self.mask, 1)
    self.seams_insertion(delta_row)
    self.out_image = self.rotate_image(self.out_image, 0)
```



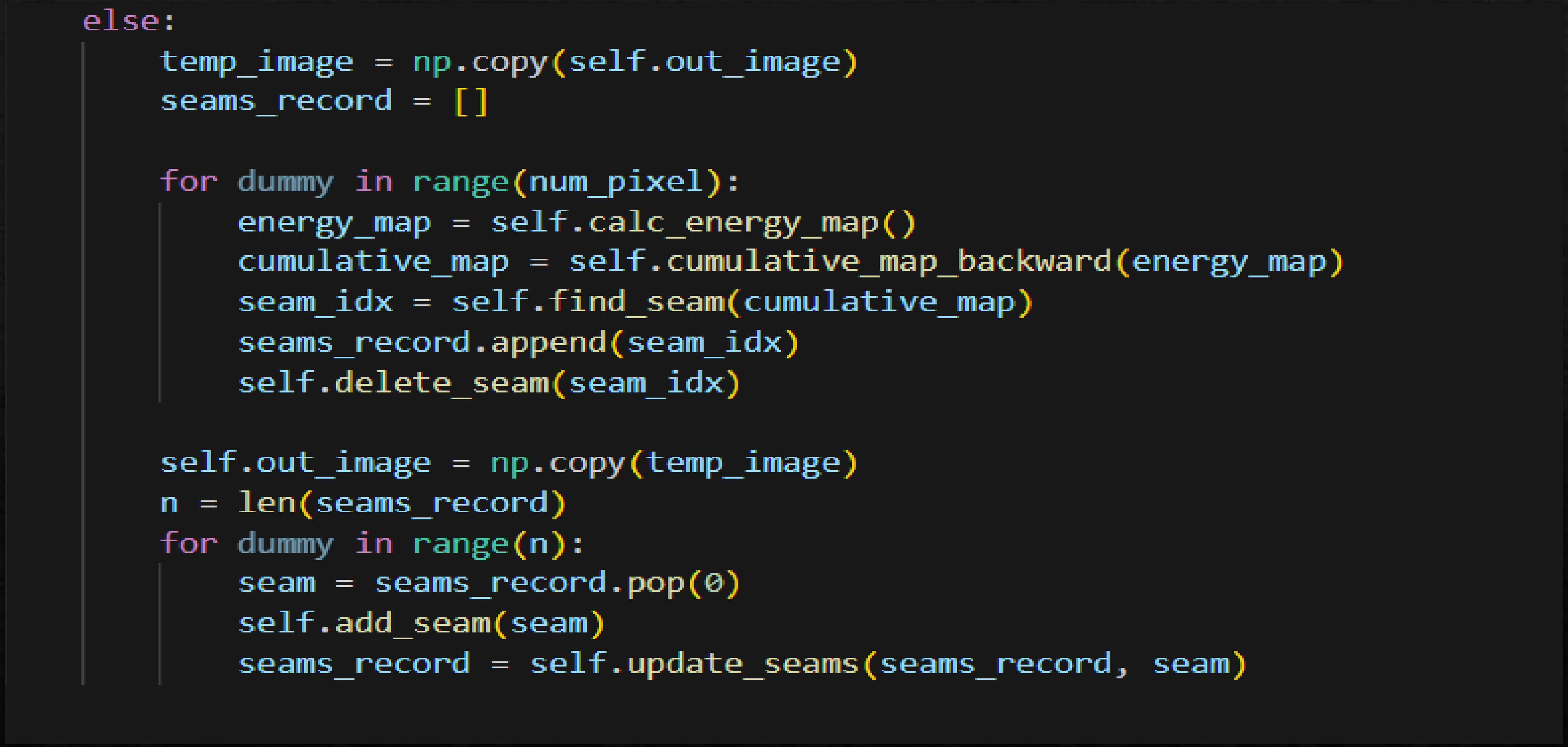
```python
def object_removal(self):
    rotate = False
    object_height, object_width = self.get_object_dimension()
    if object_height < object_width:
        self.out_image = self.rotate_image(self.out_image, 1)
        self.mask = self.rotate_mask(self.mask, 1)
        rotate = True

    while len(np.where(self.mask[:, :] > 0)[0]) > 0:
        energy_map = self.calc_energy_map()
        energy_map[np.where(self.mask[:, :] > 0)] *= -self.constant
        cumulative_map = self.cumulative_map_forward(energy_map)
        seam_idx = self.find_seam(cumulative_map)
        self.delete_seam(seam_idx)
        self.delete_seam_on_mask(seam_idx)

    if not rotate:
        num_pixels = self.in_width - self.out_image.shape[1]
    else:
        num_pixels = self.in_height - self.out_image.shape[1]

    self.seams_insertion(num_pixels)
    if rotate:
        self.out_image = self.rotate_image(self.out_image, 0)
```



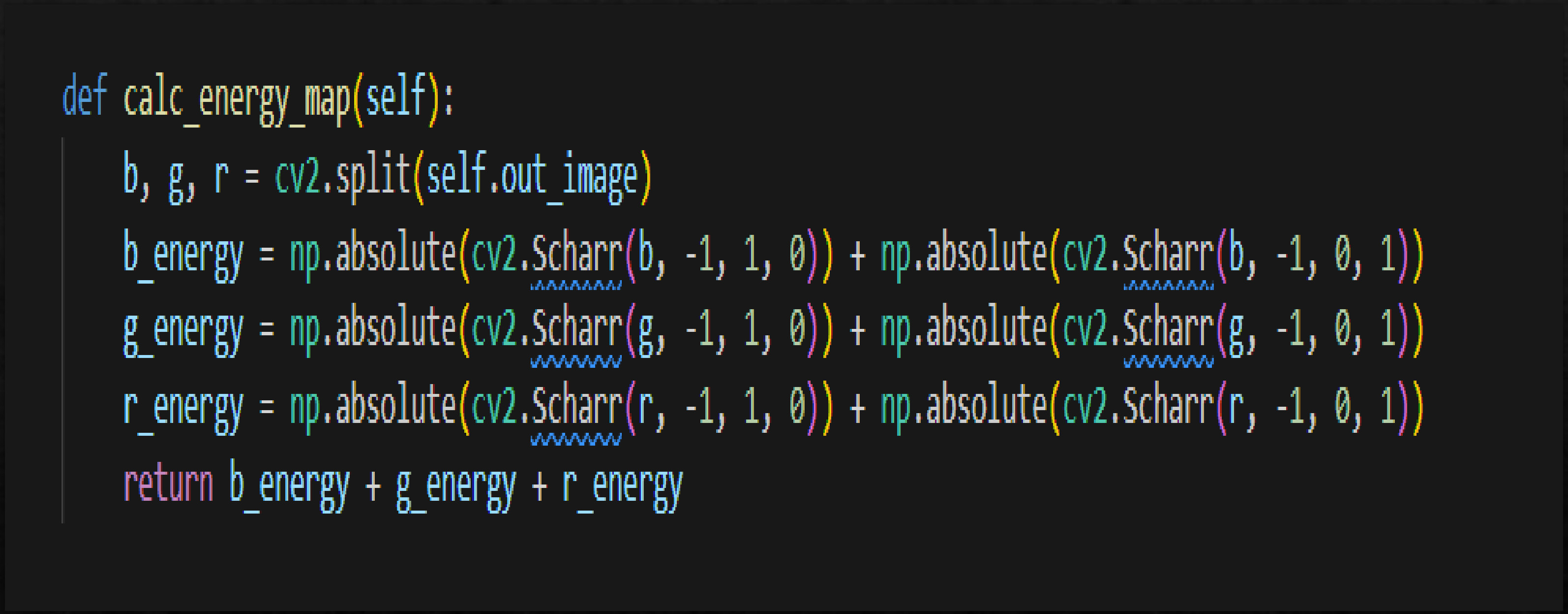
```python
def seams_removal(self, num_pixel):
    if self.protect:
        for dummy in range(num_pixel):
            energy_map = self.calc_energy_map()
            energy_map[np.where(self.mask > 0)] *= self.constant
            cumulative_map = self.cumulative_map_forward(energy_map)
            seam_idx = self.find_seam(cumulative_map)
            self.delete_seam(seam_idx)
            self.delete_seam_on_mask(seam_idx)
    else:
        for dummy in range(num_pixel):
            energy_map = self.calc_energy_map()
            cumulative_map = self.cumulative_map_forward(energy_map)
            seam_idx = self.find_seam(cumulative_map)
            self.delete_seam(seam_idx)
```



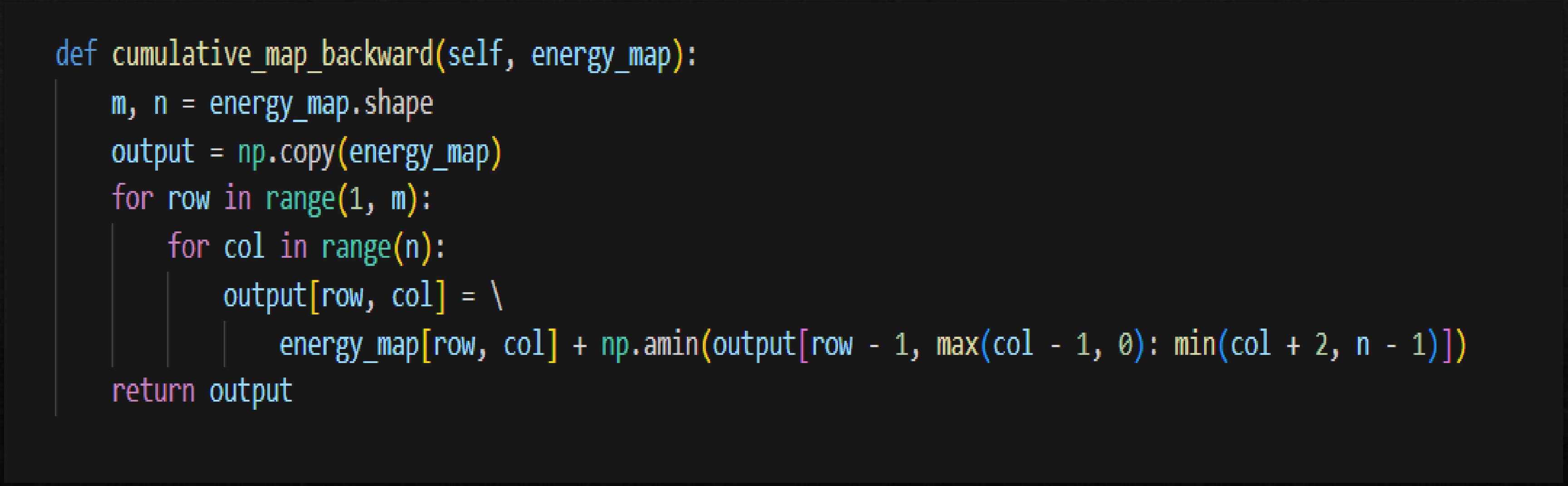
```python
def seams_insertion(self, num_pixel):
    if self.protect:
        temp_image = np.copy(self.out_image)
        temp_mask = np.copy(self.mask)
        seams_record = []

        for dummy in range(num_pixel):
            energy_map = self.calc_energy_map()
            energy_map[np.where(self.mask[:, :] > 0)] *= self.constant
            cumulative_map = self.cumulative_map_backward(energy_map)
            seam_idx = self.find_seam(cumulative_map)
            seams_record.append(seam_idx)
            self.delete_seam(seam_idx)
            self.delete_seam_on_mask(seam_idx)

        self.out_image = np.copy(temp_image)
        self.mask = np.copy(temp_mask)
        n = len(seams_record)
        for dummy in range(n):
            seam = seams_record.pop(0)
            self.add_seam(seam)
            self.add_seam_on_mask(seam)
            seams_record = self.update_seams(seams_record, seam)
    else:
```



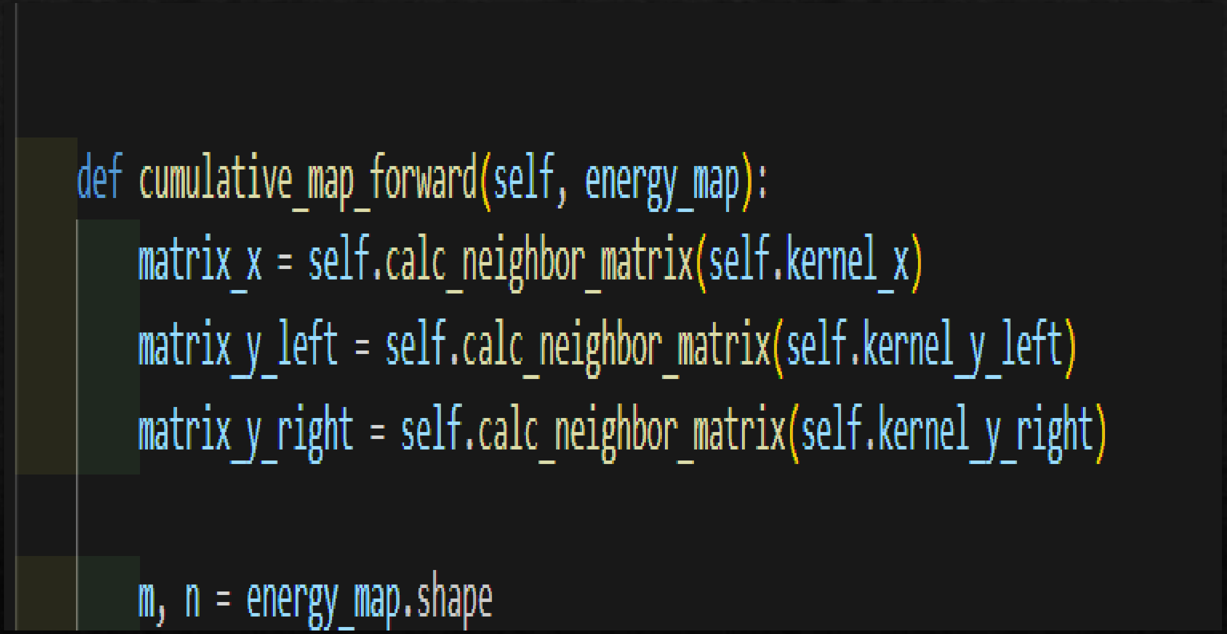
```
else:
    temp_image = np.copy(self.out_image)
    seams_record = []

    for dummy in range(num_pixel):
        energy_map = self.calc_energy_map()
        cumulative_map = self.cumulative_map_backward(energy_map)
        seam_idx = self.find_seam(cumulative_map)
        seams_record.append(seam_idx)
        self.delete_seam(seam_idx)

    self.out_image = np.copy(temp_image)
    n = len(seams_record)
    for dummy in range(n):
        seam = seams_record.pop(0)
        self.add_seam(seam)
        seams_record = self.update_seams(seams_record, seam)
```



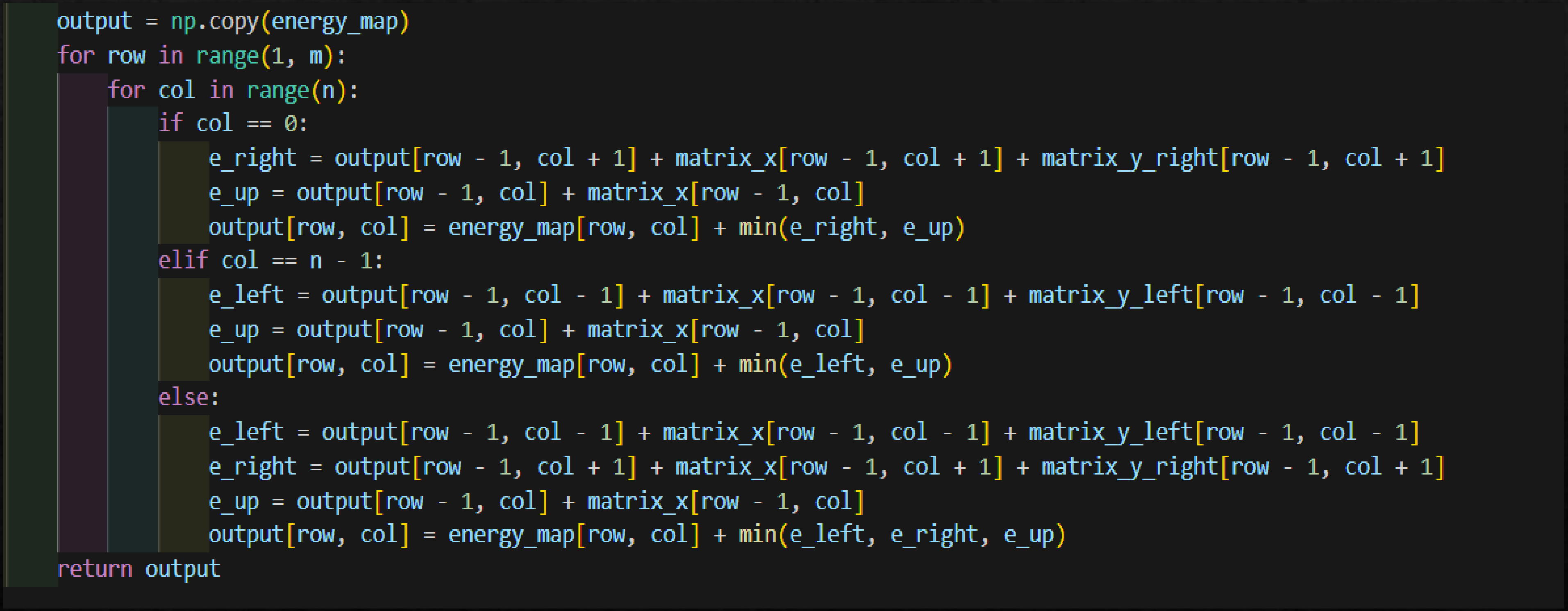
```python
def calc_energy_map(self):
    b, g, r = cv2.split(self.out_image)
    b_energy = np.absolute(cv2.Scharr(b, -1, 1, 0)) + np.absolute(cv2.Scharr(b, -1, 0, 1))
    g_energy = np.absolute(cv2.Scharr(g, -1, 1, 0)) + np.absolute(cv2.Scharr(g, -1, 0, 1))
    r_energy = np.absolute(cv2.Scharr(r, -1, 1, 0)) + np.absolute(cv2.Scharr(r, -1, 0, 1))
    return b_energy + g_energy + r_energy
```



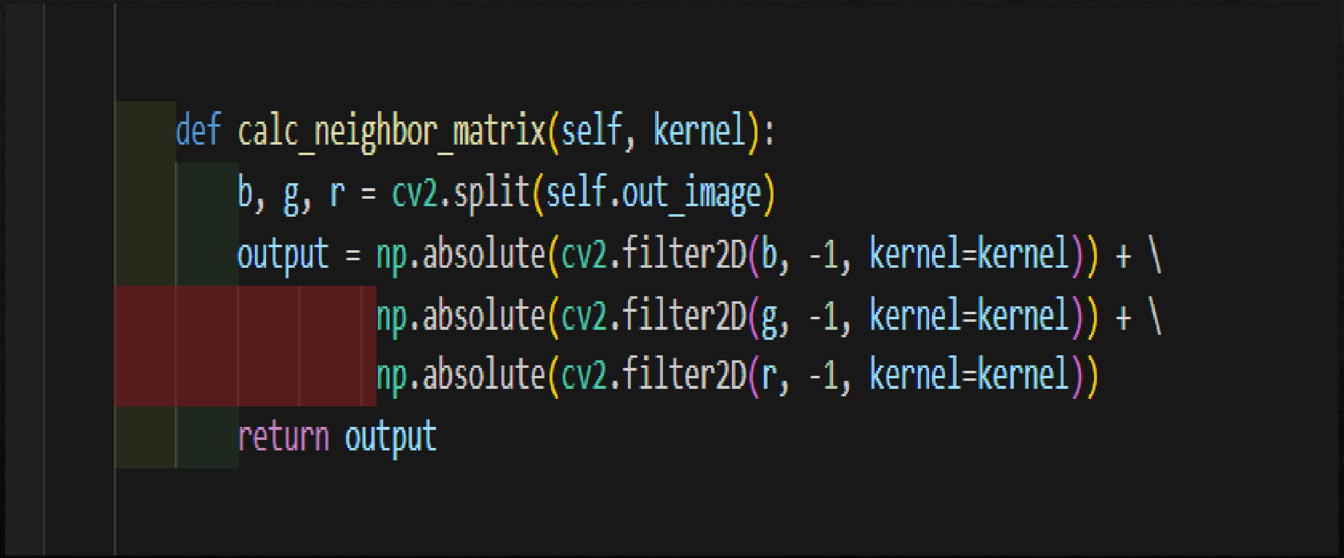
```python
def cumulative_map_backward(self, energy_map):
    m, n = energy_map.shape
    output = np.copy(energy_map)
    for row in range(1, m):
        for col in range(n):
            output[row, col] = \
                energy_map[row, col] + np.amin(output[row - 1, max(col - 1, 0): min(col + 2, n - 1)])
    return output
```



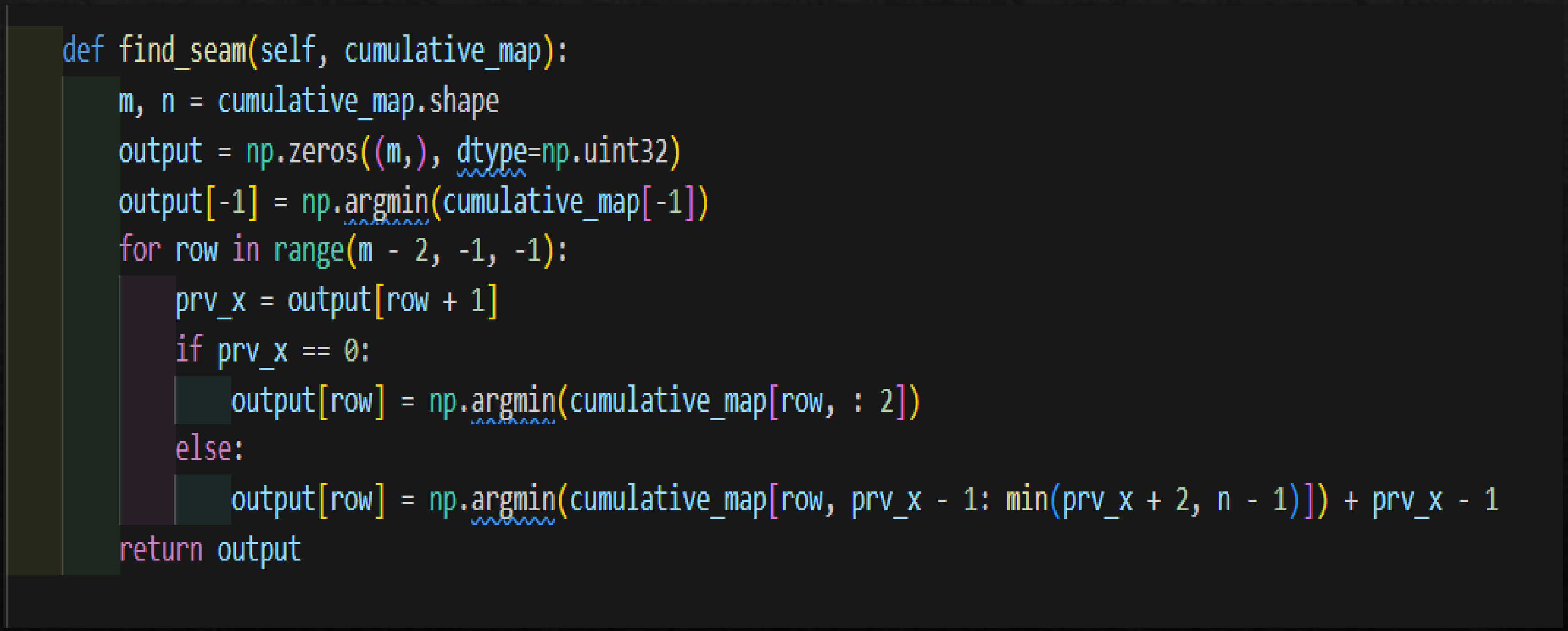
```
def cumulative_map_forward(self, energy_map):
    matrix_x = self.calc_neighbor_matrix(self.kernel_x)
    matrix_y_left = self.calc_neighbor_matrix(self.kernel_y_left)
    matrix_y_right = self.calc_neighbor_matrix(self.kernel_y_right)

    m, n = energy_map.shape
```



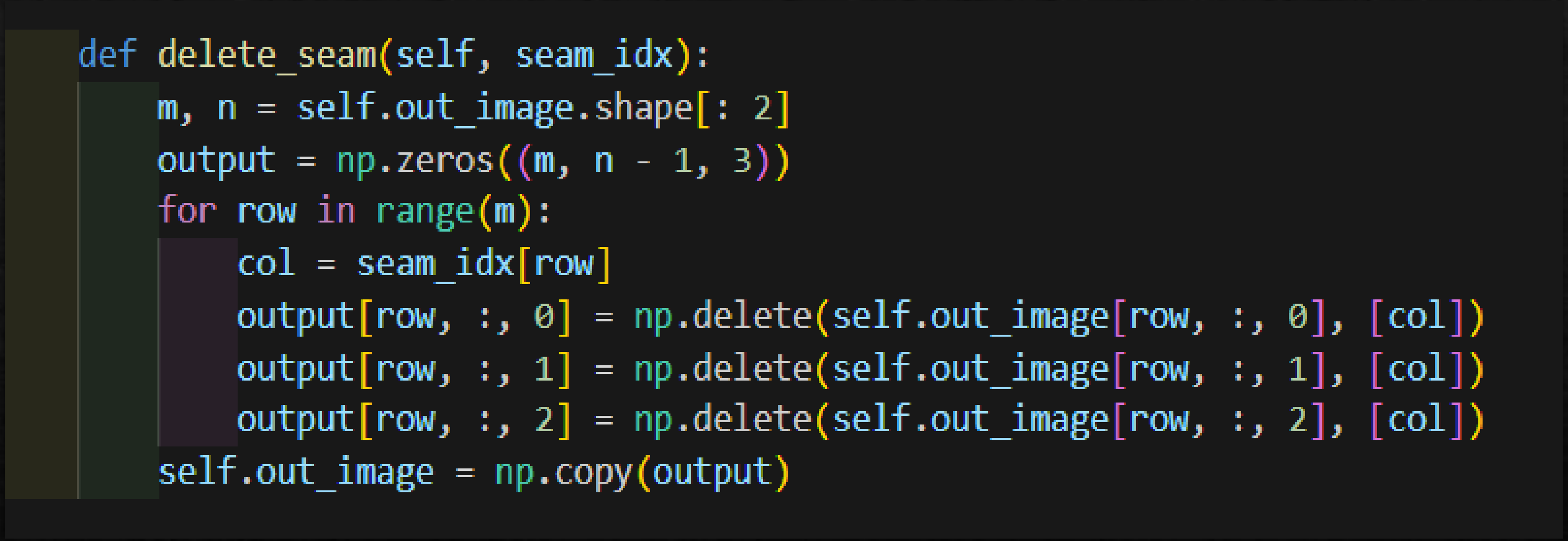
```python
output = np.copy(energy_map)
for row in range(1, m):
    for col in range(n):
        if col == 0:
            e_right = output[row - 1, col + 1] + matrix_x[row - 1, col + 1] + matrix_y_right[row - 1, col + 1]
            e_up = output[row - 1, col] + matrix_x[row - 1, col]
            output[row, col] = energy_map[row, col] + min(e_right, e_up)
        elif col == n - 1:
            e_left = output[row - 1, col - 1] + matrix_x[row - 1, col - 1] + matrix_y_left[row - 1, col - 1]
            e_up = output[row - 1, col] + matrix_x[row - 1, col]
            output[row, col] = energy_map[row, col] + min(e_left, e_up)
        else:
            e_left = output[row - 1, col - 1] + matrix_x[row - 1, col - 1] + matrix_y_left[row - 1, col - 1]
            e_right = output[row - 1, col + 1] + matrix_x[row - 1, col + 1] + matrix_y_right[row - 1, col + 1]
            e_up = output[row - 1, col] + matrix_x[row - 1, col]
            output[row, col] = energy_map[row, col] + min(e_left, e_right, e_up)
return output
```



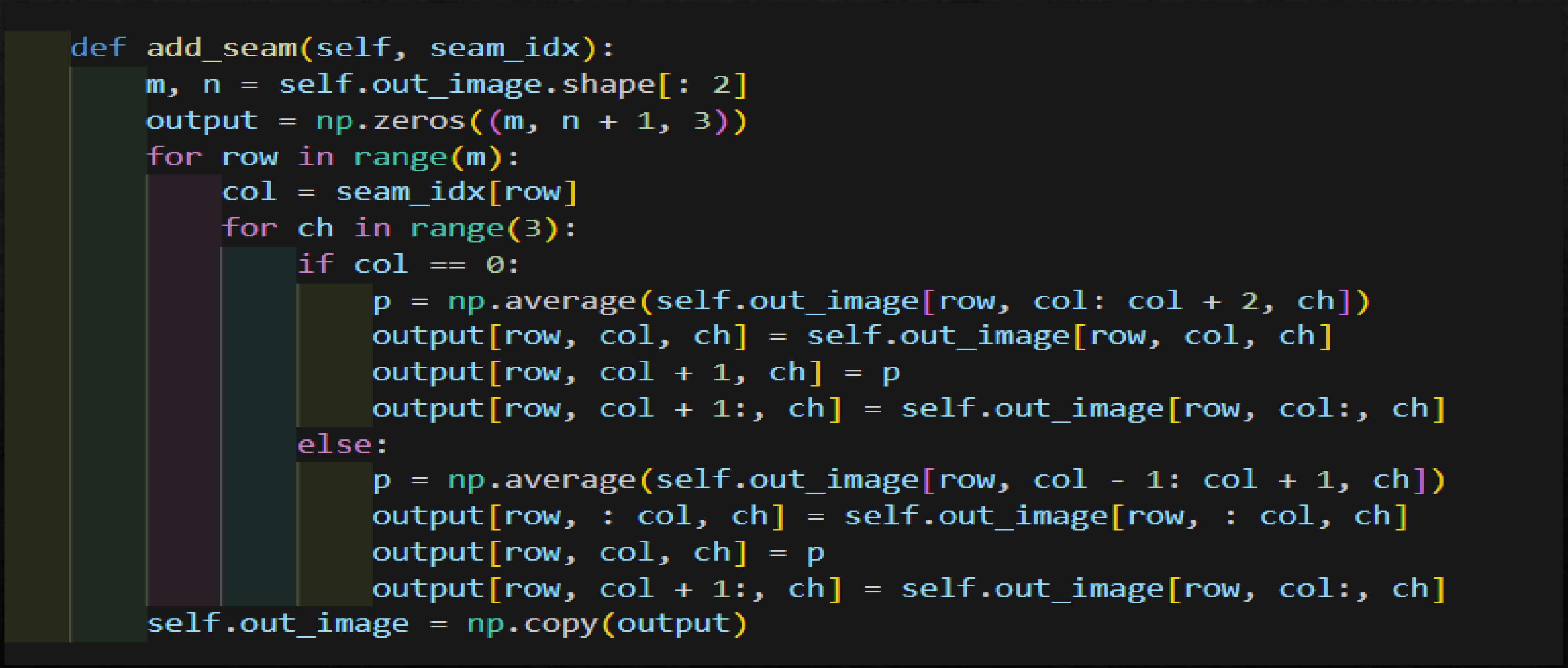
```python
def calc_neighbor_matrix(self, kernel):
    b, g, r = cv2.split(self.out_image)
    output = np.absolute(cv2.filter2D(b, -1, kernel=kernel)) + \
             np.absolute(cv2.filter2D(g, -1, kernel=kernel)) + \
             np.absolute(cv2.filter2D(r, -1, kernel=kernel))
    return output
```



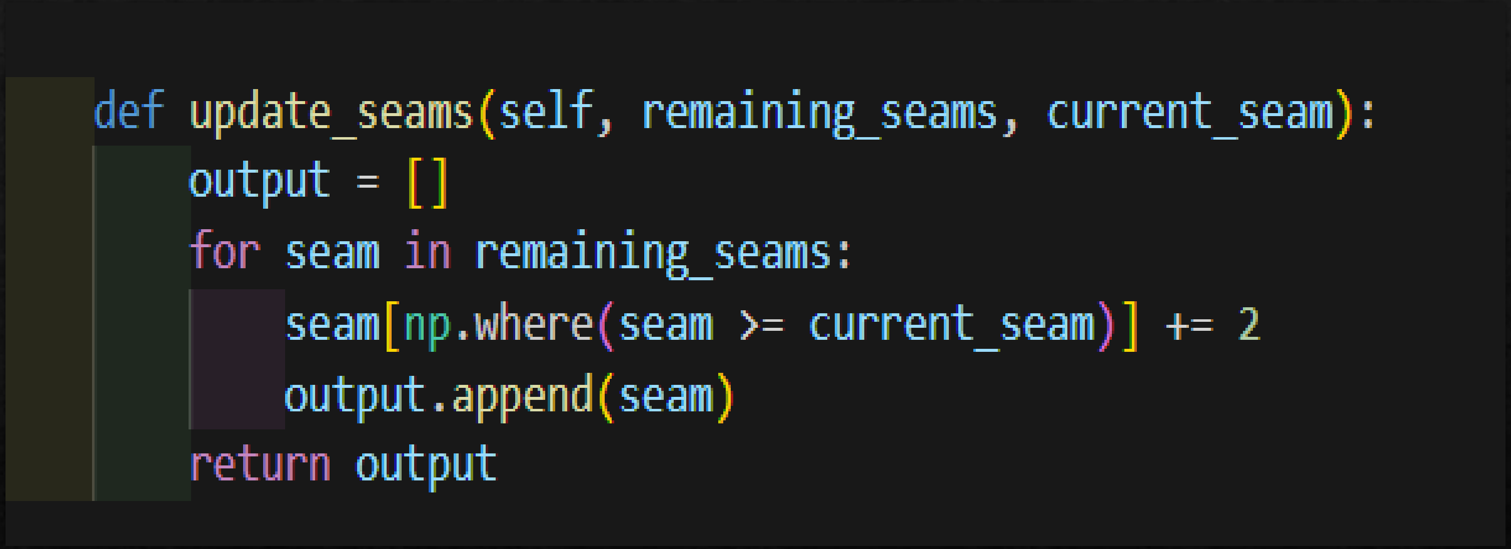
```python
def find_seam(self, cumulative_map):
    m, n = cumulative_map.shape
    output = np.zeros((m,), dtype=np.uint32)
    output[-1] = np.argmin(cumulative_map[-1])
    for row in range(m - 2, -1, -1):
        prv_x = output[row + 1]
        if prv_x == 0:
            output[row] = np.argmin(cumulative_map[row, : 2])
        else:
            output[row] = np.argmin(cumulative_map[row, prv_x - 1: min(prv_x + 2, n - 1)]) + prv_x - 1
    return output
```



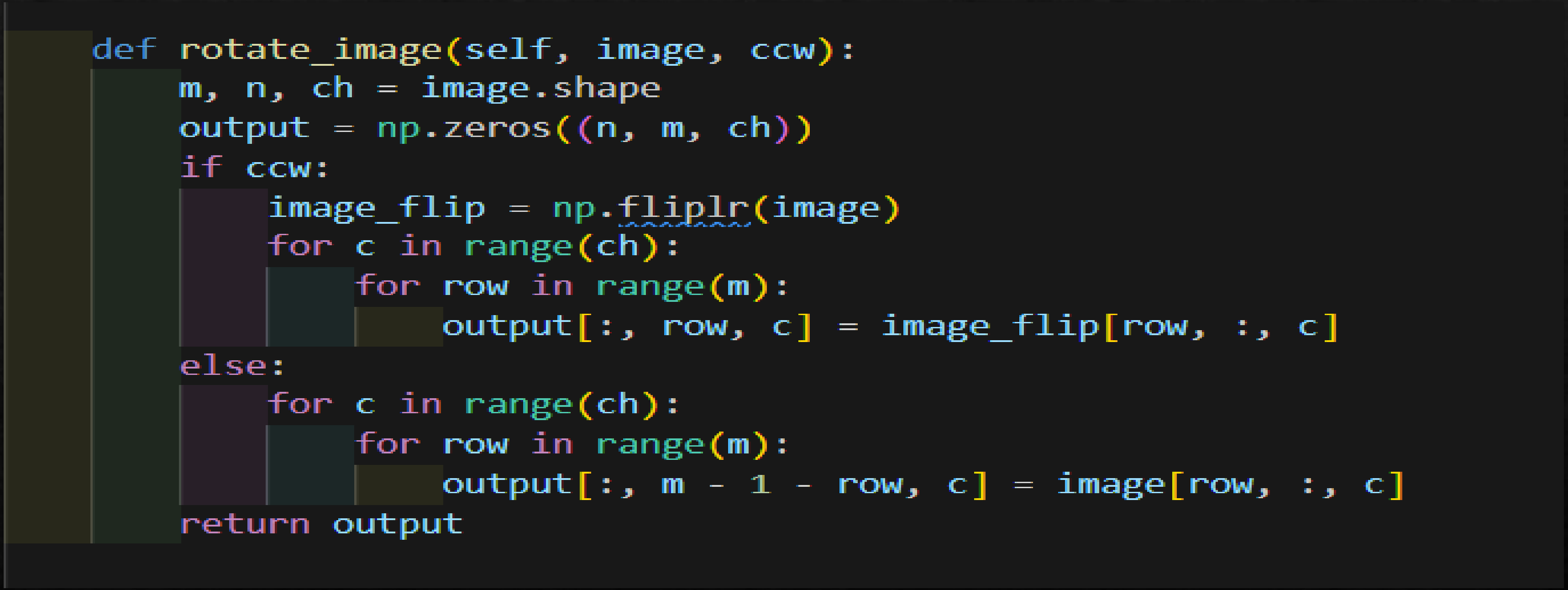
```python
def delete_seam(self, seam_idx):
    m, n = self.out_image.shape[: 2]
    output = np.zeros((m, n - 1, 3))
    for row in range(m):
        col = seam_idx[row]
        output[row, :, 0] = np.delete(self.out_image[row, :, 0], [col])
        output[row, :, 1] = np.delete(self.out_image[row, :, 1], [col])
        output[row, :, 2] = np.delete(self.out_image[row, :, 2], [col])
    self.out_image = np.copy(output)
```



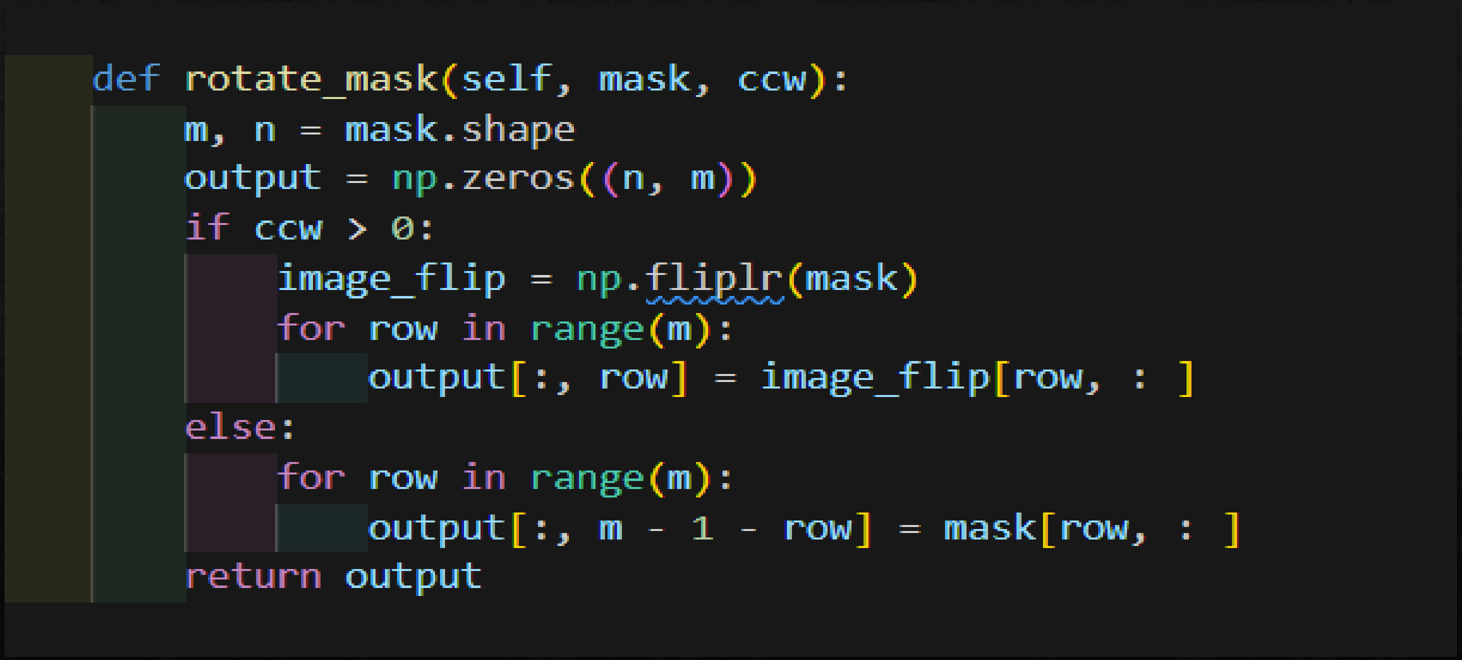
```
def add_seam(self, seam_idx):
    m, n = self.out_image.shape[: 2]
    output = np.zeros((m, n + 1, 3))
    for row in range(m):
        col = seam_idx[row]
        for ch in range(3):
            if col == 0:
                p = np.average(self.out_image[row, col: col + 2, ch])
                output[row, col, ch] = self.out_image[row, col, ch]
                output[row, col + 1, ch] = p
                output[row, col + 1:, ch] = self.out_image[row, col:, ch]
            else:
                p = np.average(self.out_image[row, col - 1: col + 1, ch])
                output[row, : col, ch] = self.out_image[row, : col, ch]
                output[row, col, ch] = p
                output[row, col + 1:, ch] = self.out_image[row, col:, ch]
    self.out_image = np.copy(output)
```



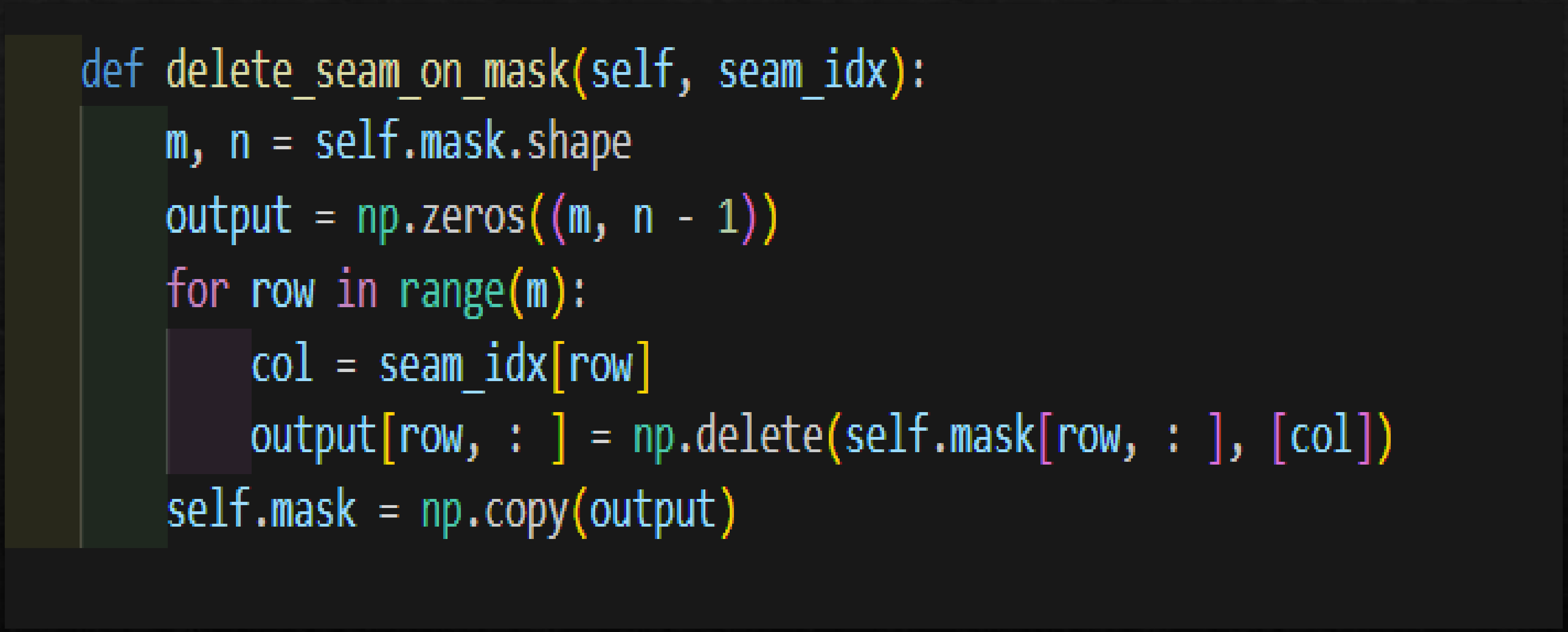
```python
def update_seams(self, remaining_seams, current_seam):
    output = []
    for seam in remaining_seams:
        seam[np.where(seam >= current_seam)] += 2
        output.append(seam)
    return output
```



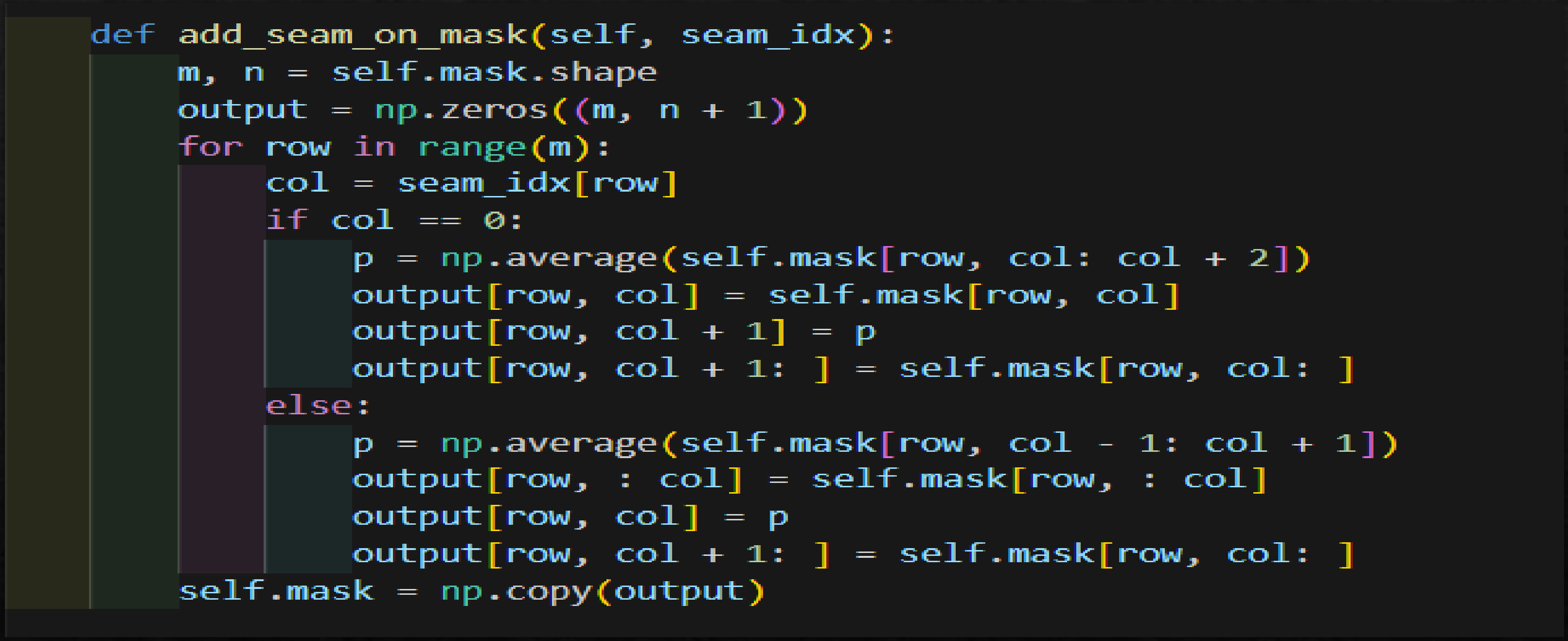
```python
def rotate_image(self, image, ccw):
    m, n, ch = image.shape
    output = np.zeros((n, m, ch))
    if ccw:
        image_flip = np.fliplr(image)
        for c in range(ch):
            for row in range(m):
                output[:, row, c] = image_flip[row, :, c]
    else:
        for c in range(ch):
            for row in range(m):
                output[:, m - 1 - row, c] = image[row, :, c]
    return output
```



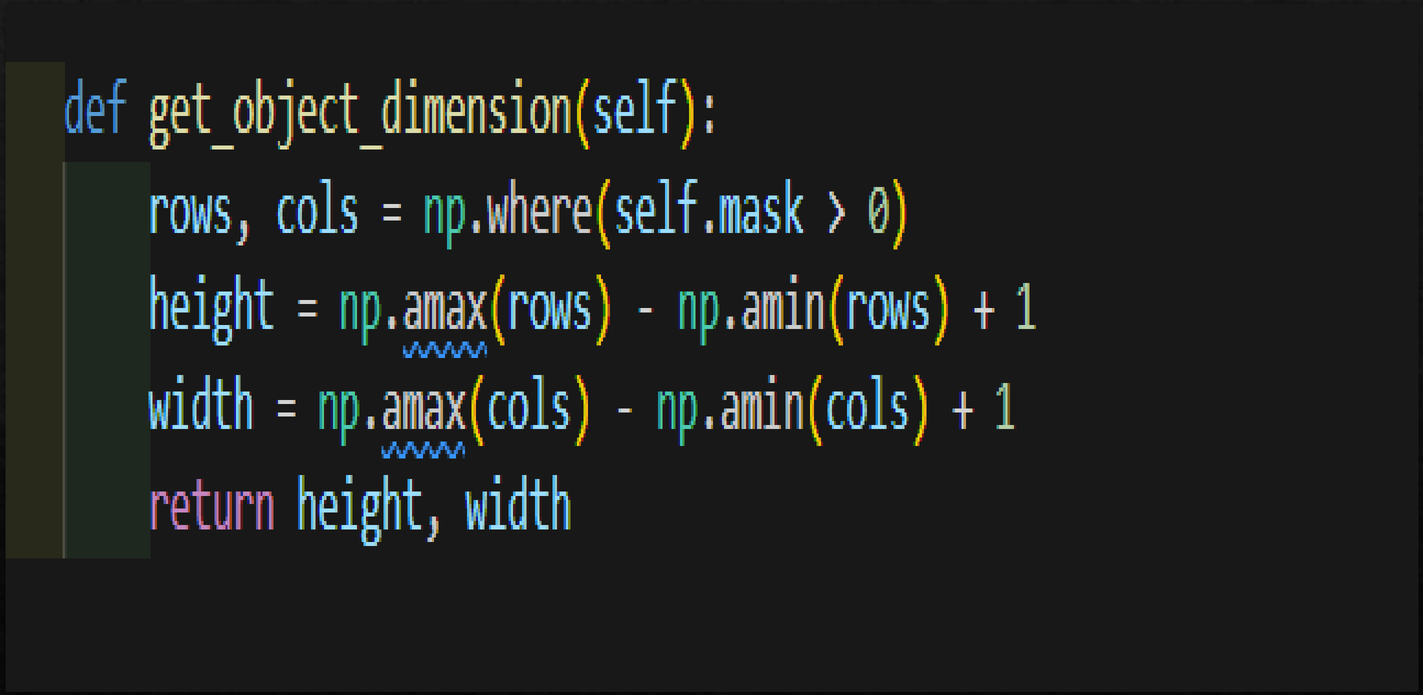
```python
def rotate_mask(self, mask, ccw):
    m, n = mask.shape
    output = np.zeros((n, m))
    if ccw > 0:
        image_flip = np.fliplr(mask)
        for row in range(m):
            output[:, row] = image_flip[row, : ]
    else:
        for row in range(m):
            output[:, m - 1 - row] = mask[row, : ]
    return output
```



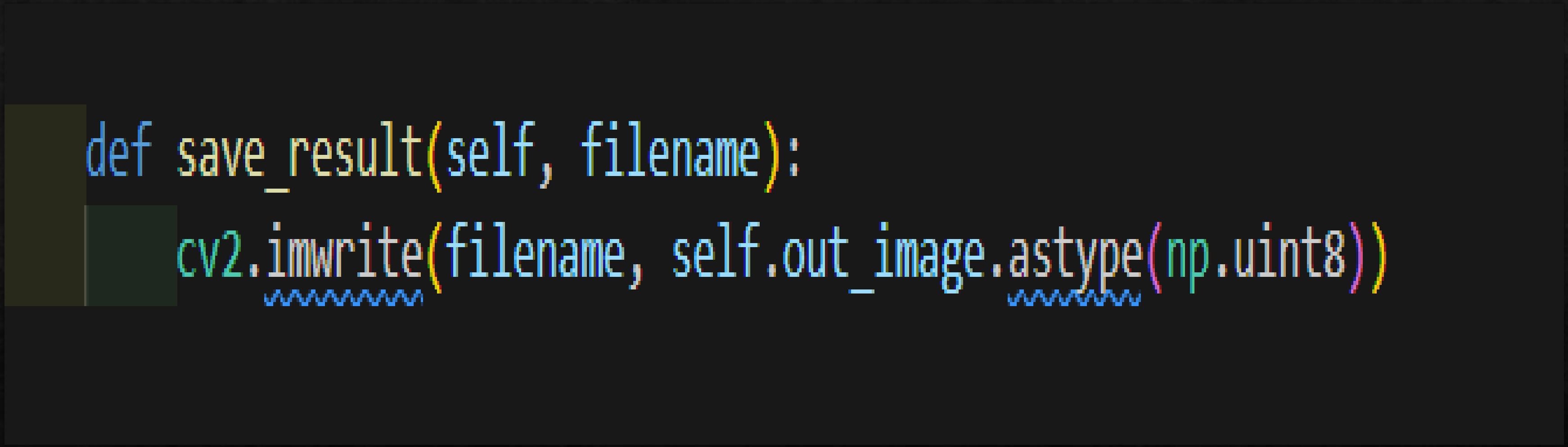
```python
def delete_seam_on_mask(self, seam_idx):
    m, n = self.mask.shape
    output = np.zeros((m, n - 1))
    for row in range(m):
        col = seam_idx[row]
        output[row, : ] = np.delete(self.mask[row, : ], [col])
    self.mask = np.copy(output)
```



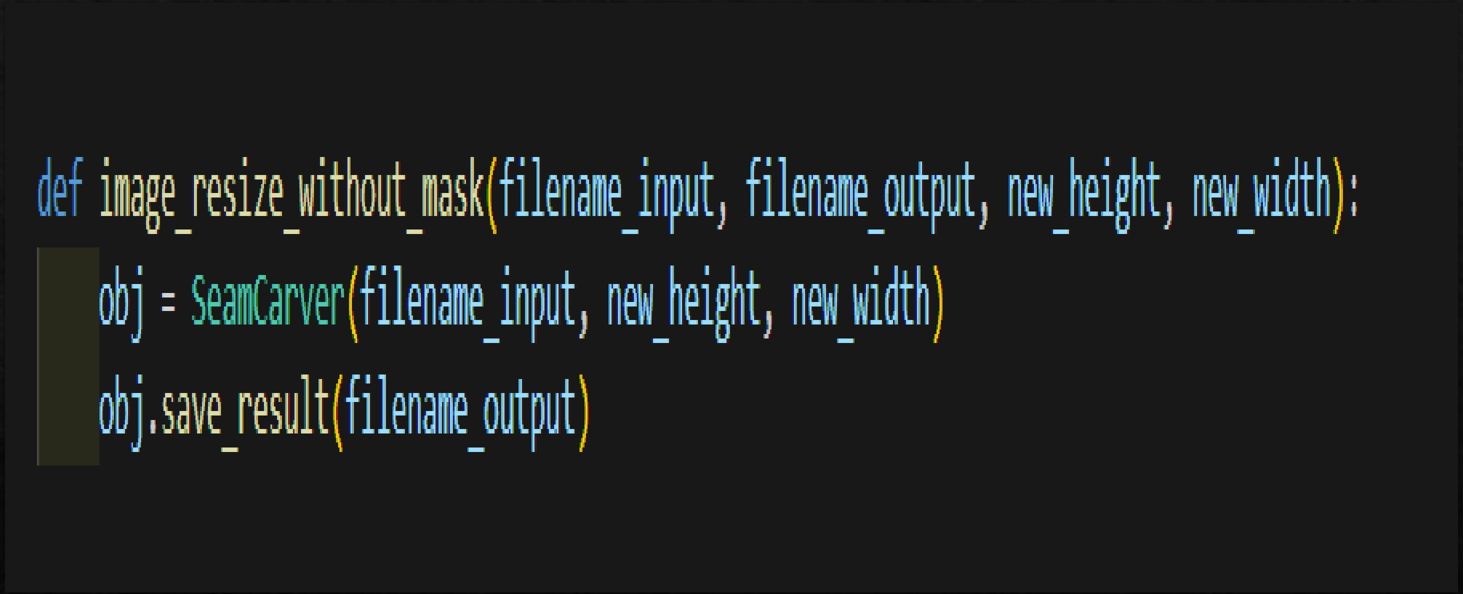
```python
def add_seam_on_mask(self, seam_idx):
    m, n = self.mask.shape
    output = np.zeros((m, n + 1))
    for row in range(m):
        col = seam_idx[row]
        if col == 0:
            p = np.average(self.mask[row, col: col + 2])
            output[row, col] = self.mask[row, col]
            output[row, col + 1] = p
            output[row, col + 1: ] = self.mask[row, col: ]
        else:
            p = np.average(self.mask[row, col - 1: col + 1])
            output[row, : col] = self.mask[row, : col]
            output[row, col] = p
            output[row, col + 1: ] = self.mask[row, col: ]
    self.mask = np.copy(output)
```



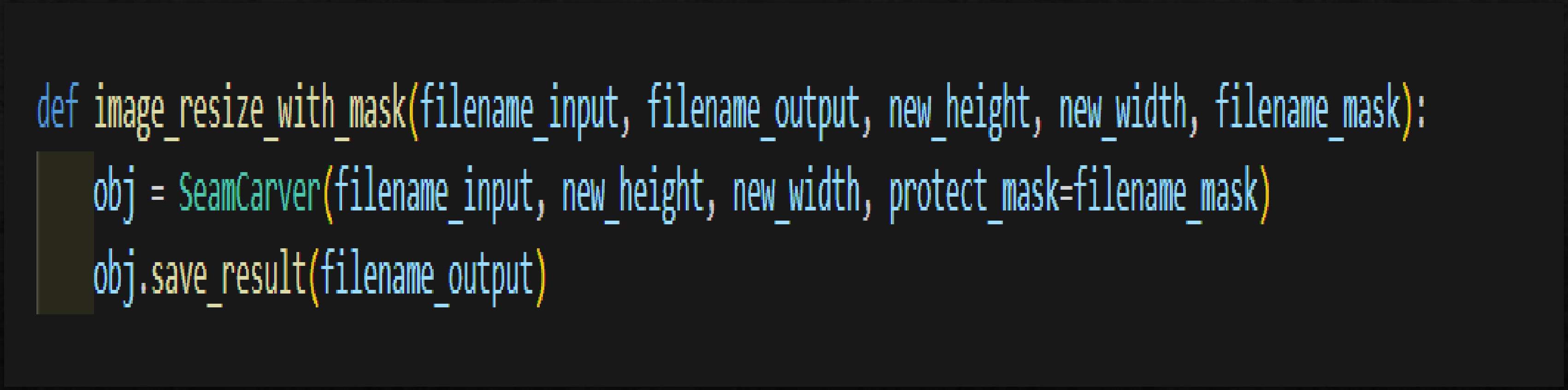
```
def get_object_dimension(self):
    rows, cols = np.where(self.mask > 0)
    height = np.amax(rows) - np.amin(rows) + 1
    width = np.amax(cols) - np.amin(cols) + 1
    return height, width
```



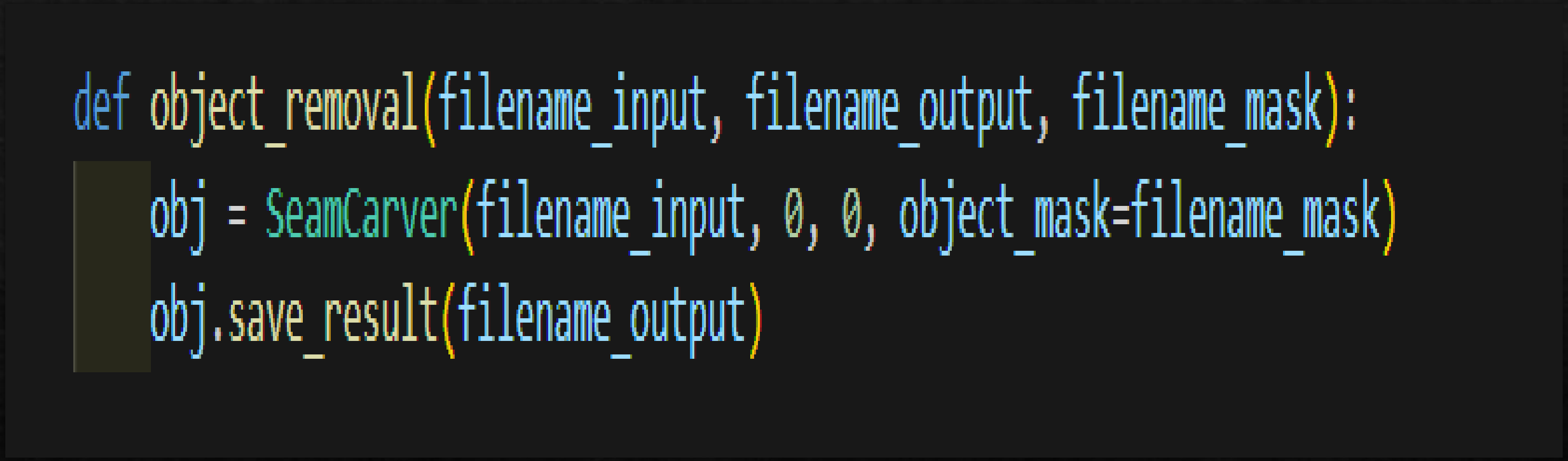
```python
def save_result(self, filename):
    cv2.imwrite(filename, self.out_image.astype(np.uint8))
```



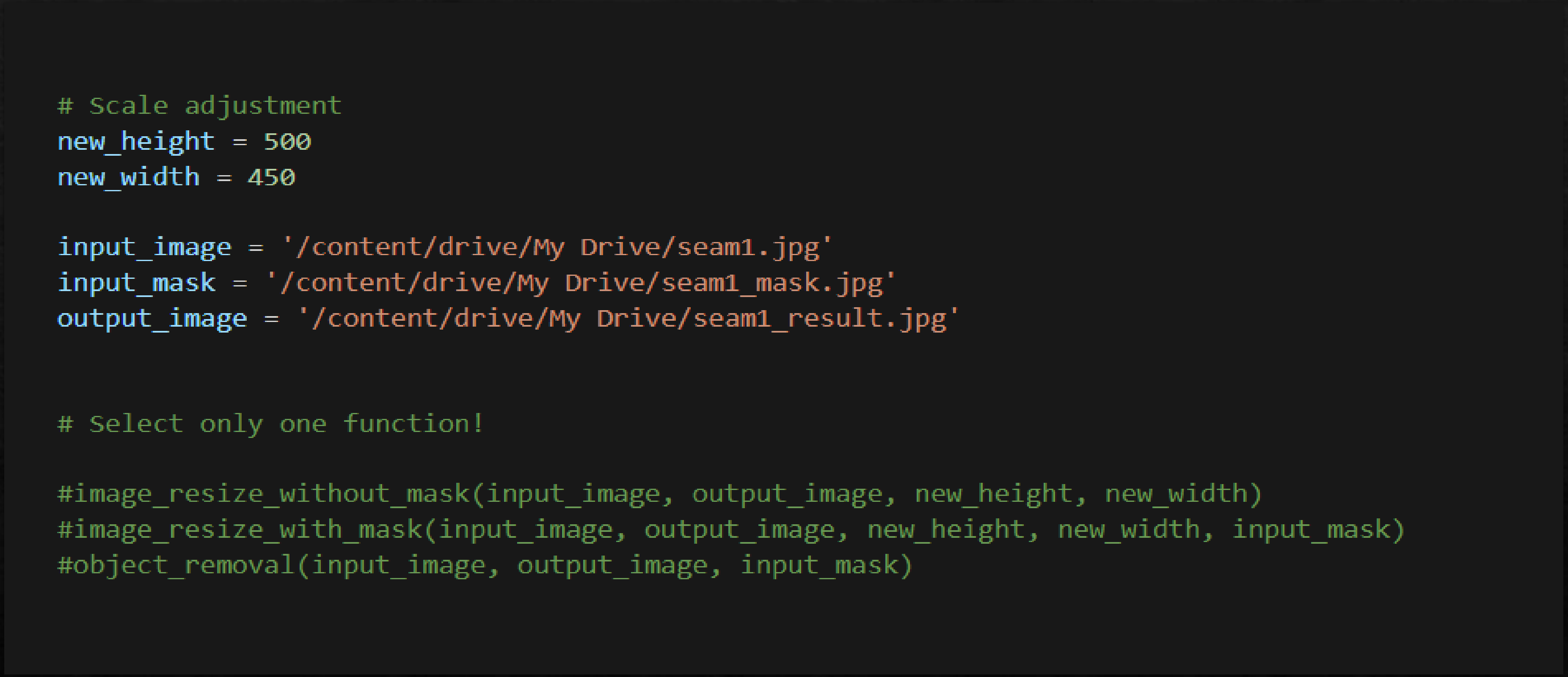
```python
def image_resize_without_mask(filename_input, filename_output, new_height, new_width):
    obj = SeamCarver(filename_input, new_height, new_width)
    obj.save_result(filename_output)
```



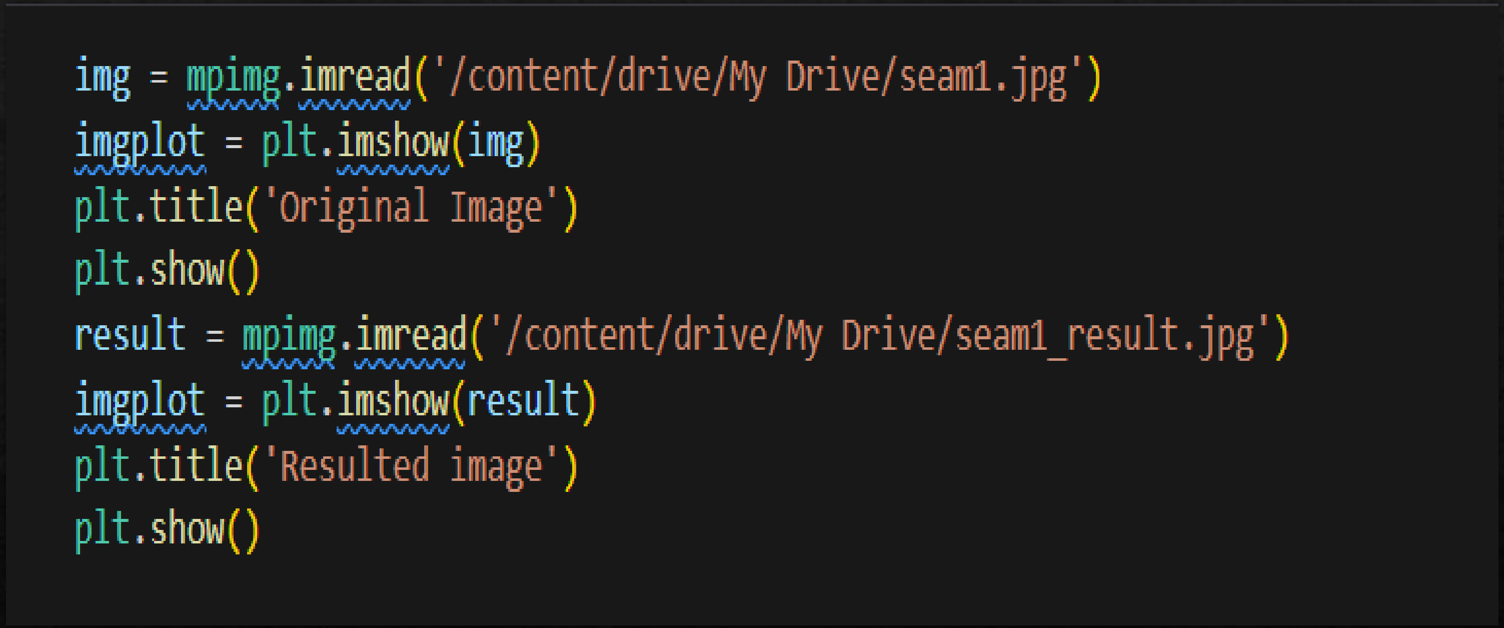
```python
def image_resize_with_mask(filename_input, filename_output, new_height, new_width, filename_mask):
    obj = SeamCarver(filename_input, new_height, new_width, protect_mask=filename_mask)
    obj.save_result(filename_output)
```



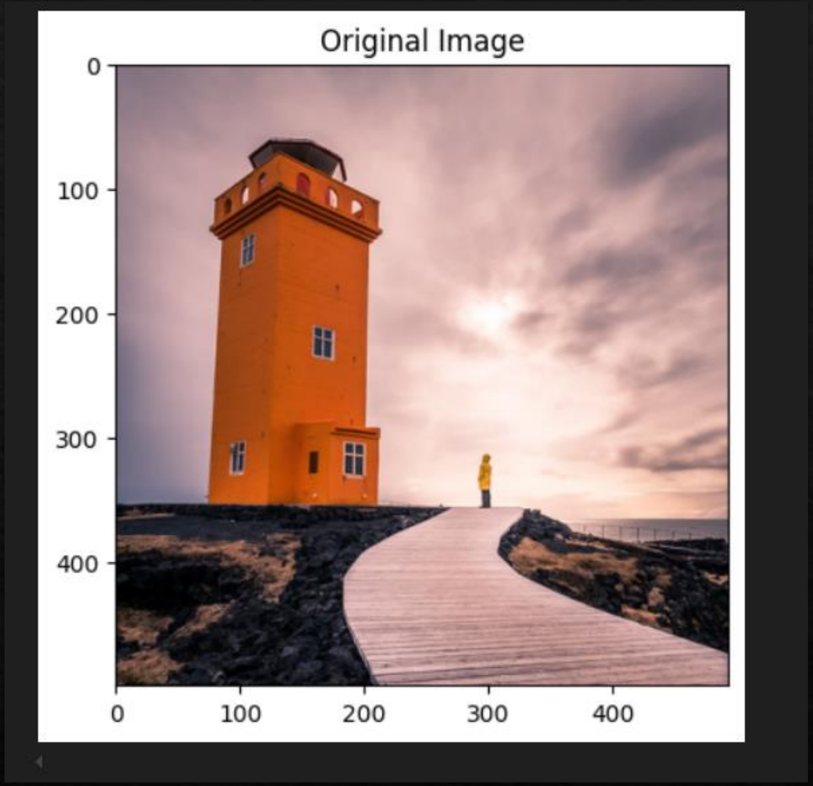
```python
def object_removal(filename_input, filename_output, filename_mask):
    obj = SeamCarver(filename_input, 0, 0, object_mask=filename_mask)
    obj.save_result(filename_output)
```

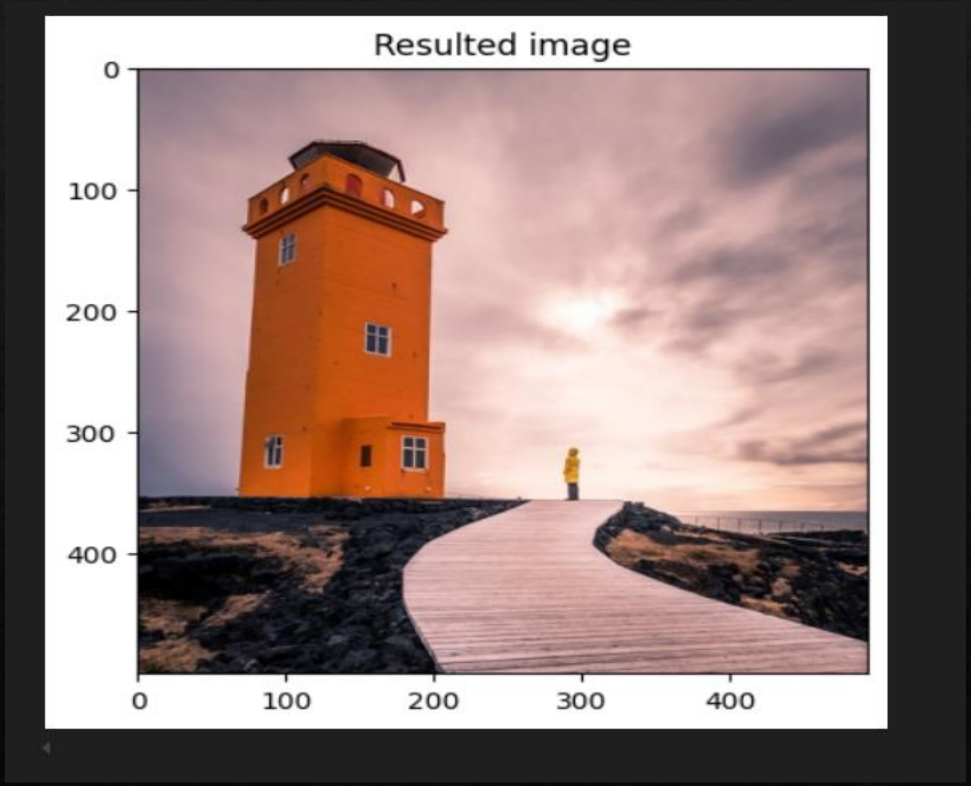


```
# Scale adjustment
new_height = 500
new_width = 450

input_image = '/content/drive/My Drive/seam1.jpg'
input_mask = '/content/drive/My Drive/seam1_mask.jpg'
output_image = '/content/drive/My Drive/seam1_result.jpg'


# Select only one function!

#image_resize_without_mask(input_image, output_image, new_height, new_width)
#image_resize_with_mask(input_image, output_image, new_height, new_width, input_mask)
#object_removal(input_image, output_image, input_mask)
```



```
img = mpimg.imread('/content/drive/My Drive/seam1.jpg')
imgplot = plt.imshow(img)
plt.title('Original Image')
plt.show()
result = mpimg.imread('/content/drive/My Drive/seam1_result.jpg')
imgplot = plt.imshow(result)
plt.title('Resulted image')
plt.show()
```


Original Image
0
100
200
300
400
0
100
200
300
400


Resulted image
0
100
200
300
400
0
100
200
300
400

The End

author:
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under the surveillance of :
Professor Khosravi