**DAA Lab Mini PROJECT Report**

On

**Seam Carving using Backtracking**

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**ABSTRACT**

Seam carving is a novel way to crop images without losing important content in the image. This is often called “content-aware” cropping or image retargeting. Its an algorithm that lets you go from this:





As you can see, most of the important content in the image: the boats, have been left intact. The algorithm removed some of the rock formations and the water.

**INTRODUCTION**

The main Idea of seam carving is resizing of image without loosing the main content in the image.



This is an image we will see how the scaled,cropped,seam carved images will look.



Another Example:

![A picture containing building, cage, hydrant

Description automatically generated](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAYABgAAD/4TOeRXhpZgAATU0AKgAAAAgABgALAAIAAAAmAAAIYgESAAMAAAABAAEAAAExAAIAAAAmAAAIiAEyAAIAAAAUAAAIrodpAAQAAAABAAAIwuocAAcAAAgMAAAAVgAAEUYc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAFdpbmRvd3MgUGhvdG8gRWRpdG9yIDEwLjAuMTAwMTEuMTYzODQAV2luZG93cyBQaG90byBFZGl0b3IgMTAuMC4xMDAxMS4xNjM4NAAyMDIwOjA1OjEzIDEyOjM0OjI3AAAGkAMAAgAAABQAABEckAQAAgAAABQAABEwkpEAAgAAAAM3OQAAkpIAAgAAAAM3OQAAoAEAAwAAAAEAAQAA6hwABwAACAwAAAkQAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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**How Algorithm Works:**

1. Assign an energy value to every pixel
2. Find an 8-connected path of the pixels with the least energy
3. Delete all the pixels in the path
4. Repeat 1-3 till the desired number of rows/columns are deleted

For the rest of this post, we’ll assume that we are only trying to crop the width of the image, i.e : remove columns. But the same concepts can be translated to rows.

### [Energy map](https://karthikkaranth.me/blog/implementing-seam-carving-with-python/#energy-map)

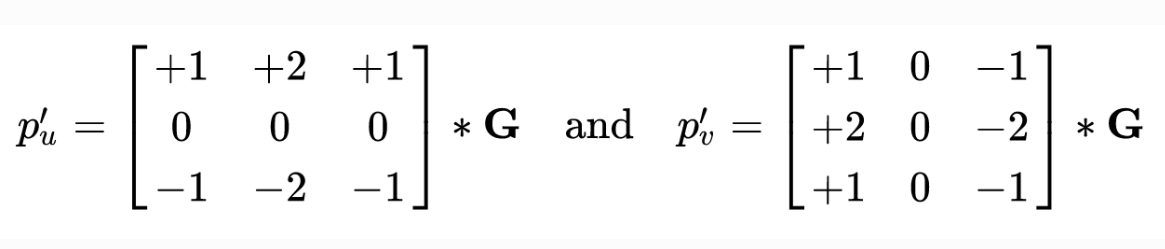
The first step is to compute an energy value for every pixel. The paper defines many different energy functions which can be used. We’ll use the most basic one:

* Find the partial derivative in the x axis
* Find the partial derivative in the y axis
* Sum their absolute values

A close up of a clock

Description automatically generated

The [**Image derivations**](https://en.wikipedia.org/wiki/Image_derivatives) page on Wikipedia points us to a number of different ways to compute the derivative of the image. We’ll be using the Sobel filter. This is a [**convolutional kernel**](http://aishack.in/tutorials/image-convolution-examples/) that is run over the image on every channel. Here is the filter in two different directions of the image:



Upon visualizing the energy map, we see:



In this image we have to calculate the the path with least energy which will be the least noticed path in the picture.

By finding all the paths as above we will remove the paths which will result the output image.

**CODE**

**import sys**

**from tqdm import trange**

**import numpy as np**

**from imageio import imread, imwrite**

**from scipy.ndimage.filters import convolve**

**def calc\_energy(img):**

**filter\_du = np.array([**

**[1.0, 2.0, 1.0],**

**[0.0, 0.0, 0.0],**

**[-1.0, -2.0, -1.0],**

**])**

**# This converts it from a 2D filter to a 3D filter, replicating the same**

**# filter for each channel: R, G, B**

**filter\_du = np.stack([filter\_du] \* 3, axis=2)**

**filter\_dv = np.array([**

**[1.0, 0.0, -1.0],**

**[2.0, 0.0, -2.0],**

**[1.0, 0.0, -1.0],**

**])**

**# This converts it from a 2D filter to a 3D filter, replicating the same**

**# filter for each channel: R, G, B**

**filter\_dv = np.stack([filter\_dv] \* 3, axis=2)**

**img = img.astype('float32')**

**convolved = np.absolute(convolve(img, filter\_du)) + np.absolute(convolve(img, filter\_dv))**

**# We sum the energies in the red, green, and blue channels**

**energy\_map = convolved.sum(axis=2)**

**return energy\_map**

**def crop\_c(img, scale\_c):**

**r, c, \_= img.shape**

**new\_c = int(scale\_c \* c)**

**for i in trange(c - new\_c):**

**img = carve\_column(img)**

**return img**

**def crop\_r(img, scale\_r):**

**img = np.rot90(img, 1, (0, 1))**

**img = crop\_c(img, scale\_r)**

**img = np.rot90(img, 3, (0, 1))**

**return img**

**def carve\_column(img):**

**r, c, k = img.shape**

**M, backtrack = minimum\_seam(img)**

**mask = np.ones((r, c), dtype=np.bool)**

**j = np.argmin(M[-1])**

**for i in reversed(range(r)):**

**mask[i, j] = False**

**j = backtrack[i, j]**

**#mask = np.stack([mask]\*3, axis=2)**

**img = img[mask].reshape(r,c-1,k)**

**return img**

**def minimum\_seam(img):**

**r, c, \_ = img.shape**

**energy\_map = calc\_energy(img)**

**M = energy\_map.copy()**

**backtrack = np.zeros\_like(M, dtype=np.int)**

**for i in range(1, r):**

**for j in range(0, c):**

**# Handle the left edge of the image, to ensure we don't index a -1**

**if j == 0:**

**idx = np.argmin(M[i-1, j:j + 2])**

**backtrack[i, j] = idx + j**

**min\_energy = M[i-1, idx + j]**

**else:**

**idx = np.argmin(M[i - 1, j - 1:j + 2])**

**backtrack[i, j] = idx + j - 1**

**min\_energy = M[i - 1, idx + j - 1]**

**M[i, j] += min\_energy**

**return M, backtrack**

**def main():**

**if len(sys.argv) != 5:**

**print('usage: carver.py <r/c> <scale> <image\_in> <image\_out>', file=sys.stderr)**

**sys.exit(1)**

**which\_axis = sys.argv[1]**

**scale = float(sys.argv[2])**

**in\_filename = sys.argv[3]**

**out\_filename = sys.argv[4]**

**img = imread(in\_filename)**

**if which\_axis == 'r':**

**out = crop\_r(img, scale)**

**elif which\_axis == 'c':**

**out = crop\_c(img, scale)**

**else:**

**print('usage: carver.py <r/c> <scale> <image\_in> <image\_out>', file=sys.stderr)**

**sys.exit(1)**

**imwrite(out\_filename, out)**

**if \_\_name\_\_ == '\_\_main\_\_':**

**main()**

**OUTPUT**

**1.Original image**

****

**2.While program is Running:**

**A screenshot of a computer screen

Description automatically generated**

**3.output image**

**A group of people running on a grassy field

Description automatically generated**

**CONCLUSION**

Seam carving is a very useful tool now. Due to the display size changing from device to device we need different image sizes for each and every device so here we can use image carving to see the images as they are without loosing important information in the image.

Future development: A simple change would be to remove multiple seams using the same computed seams for the image. In this experiment, this can make the algorithm faster, almost linearly with respect to the number of seams removed per iteration. However, there is a noticable loss in quality. Another optimization is computing the energy map on the GPU.

\

**REFERENCES**

* <https://www.youtube.com/watch?v=6NcIJXTlugc>
* <https://karthikkaranth.me/blog/implementing-seam-carving-with-python/>