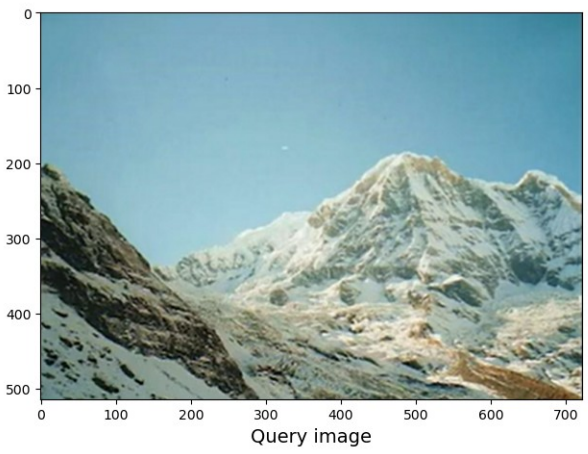
```
import cv2
import numpy as np
import matplotlib.pyplot as plt
import imageio
cv2.ocl.setUseOpenCL(False)
import warnings
warnings.filterwarnings('ignore')

feature_extraction_algo = 'sift'

feature_to_match = 'bf'

# Right
train_photo = cv2.imread('./'  + 'myimg1.png')

train_photo = cv2.cvtColor(train_photo,cv2.COLOR_BGR2RGB)

train_photo_gray = cv2.cvtColor(train_photo, cv2.COLOR_RGB2GRAY)

# Left
query_photo = cv2.imread('./'  + 'myimg2.png')
query_photo = cv2.cvtColor(query_photo,cv2.COLOR_BGR2RGB)
query_photo_gray = cv2.cvtColor(query_photo, cv2.COLOR_RGB2GRAY)

fig, (ax1, ax2) = plt.subplots(nrows=1, ncols=2,
constrained_layout=False, figsize=(16,9))
ax1.imshow(query_photo, cmap="gray")
ax1.set_xlabel("Query image", fontsize=14)

ax2.imshow(train_photo, cmap="gray")
ax2.set_xlabel("Train image (Image to be transformed)", fontsize=14)

# plt.savefig("./_"+'.jpeg', bbox_inches='tight', dpi=300,
optimize=True, format='jpeg')

plt.show()
```

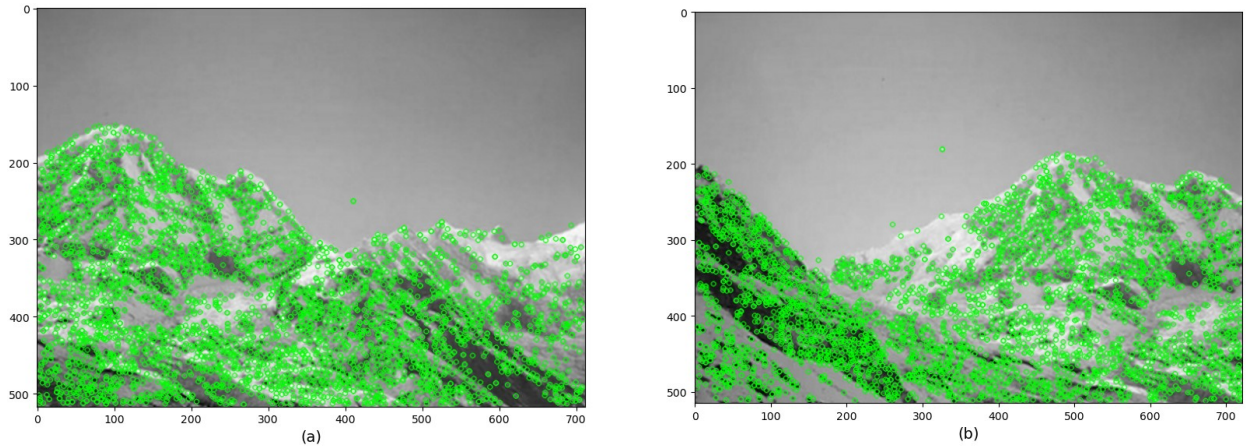


```
def select_descriptor_methods(image, method=None):

    assert method is not None, "Please define a feature descriptor
method. accepted Values are: 'sift', 'surf'"

    if method == 'sift':
        descriptor = cv2.SIFT_create()
    elif method == 'surf':
        descriptor = cv2.SURF_create()
    elif method == 'brisk':
        descriptor = cv2.BRISK_create()
    elif method == 'orb':
        descriptor = cv2.ORB_create()

    (keypoints, features) = descriptor.detectAndCompute(image, None)

    return (keypoints, features)

keypoints_train_img, features_train_img =
select_descriptor_methods(train_photo_gray,
method=feature_extraction_algo)

keypoints_query_img, features_query_img =
select_descriptor_methods(query_photo_gray,
method=feature_extraction_algo)

# for keypoint in keypoints_query_img:
#     x,y = keypoint.pt
#     size = keypoint.size
#     orientation = keypoint.angle
#     response = keypoint.response
#     octave = keypoint.octave
#     class_id = keypoint.class_id


# print (x,y)

# print(size)

# print(orientation)

# print(response)
# print(octave)
# print(class_id)

print(len(keypoints_query_img))

features_query_img.shape
```

```
3703
```

```
(3703, 128)
```

```
fig, (ax1,ax2) = plt.subplots(nrows=1, ncols=2, figsize=(20,8),
constrained_layout=False)

ax1.imshow(cv2.drawKeypoints(train_photo_gray, keypoints_train_img,
None, color=(0,255,0)))

ax1.set_xlabel("(a)", fontsize=14)

ax2.imshow(cv2.drawKeypoints(query_photo_gray,keypoints_query_img,None
,color=(0,255,0)))
ax2.set_xlabel("(b)", fontsize=14)

plt.savefig("./output/" + feature_extraction_algo +
"_features_img_"+'.jpeg', bbox_inches='tight',
            dpi=300, format='jpeg')
plt.show()
```

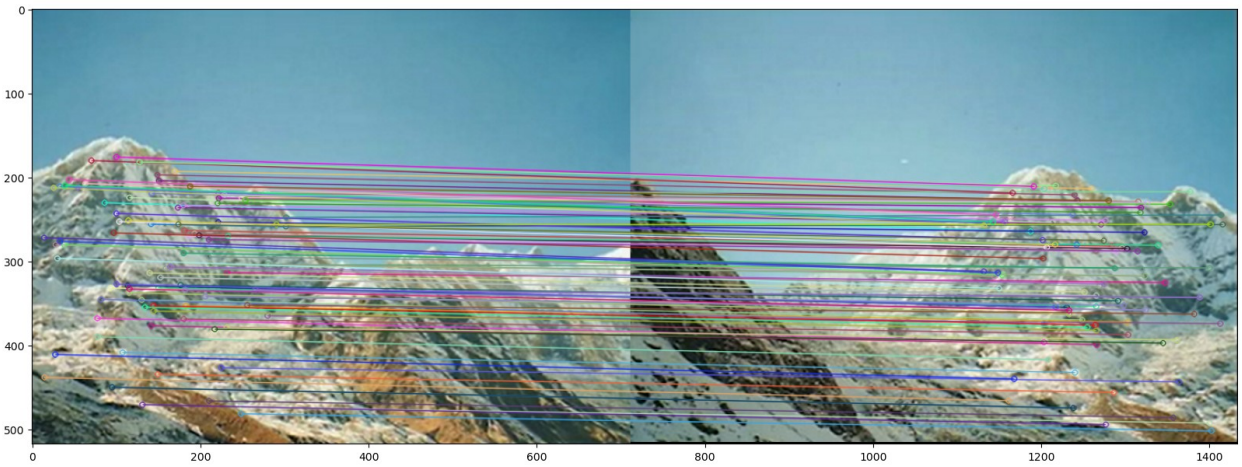



```
def create_matching_object(method,crossCheck):
    "Create and return a Matcher Object"

    if method == 'sift' or method == 'surf':
        bf = cv2.BFMatcher(cv2.NORM_L2, crossCheck=crossCheck)
    elif method == 'orb' or method == 'brisk':
        bf = cv2.BFMatcher(cv2.NORM_HAMMING, crossCheck=crossCheck)
    return bf

def key_points_matching(features_train_img, features_query_img,
method):
    """
    Perform key points matching between the features of a train image
and a query image using a specified method.
    """
    bf = create_matching_object(method, crossCheck=True)
```

```
    best_matches = bf.match(features_train_img,features_query_img)

    rawMatches = sorted(best_matches, key = lambda x:x.distance)
    print("Raw matches with Brute force):", len(rawMatches))
    return rawMatches

def key_points_matching_KNN(features_train_img, features_query_img,
ratio, method):
    """
    Perform key points matching using K-Nearest Neighbors (KNN)
algorithm.
    """
    bf = create_matching_object(method, crossCheck=False)

    rawMatches = bf.knnMatch(features_train_img, features_query_img,
k=2)
    print("Raw matches (knn):", len(rawMatches))
    matches = []


    for m,n in rawMatches:
        if m.distance < n.distance * ratio:
            matches.append(m)
    return matches

print("Drawing: {} matched features Lines".format(feature_to_match))

fig = plt.figure(figsize=(20,8))

if feature_to_match == 'bf':
    matches = key_points_matching(features_train_img,
features_query_img, method=feature_extraction_algo)

    mapped_features_image =
cv2.drawMatches(train_photo,keypoints_train_img,query_photo,keypoints_
query_img,matches[:100],

None,flags=cv2.DrawMatchesFlags_NOT_DRAW_SINGLE_POINTS)


elif feature_to_match == 'knn':
    matches = key_points_matching_KNN(features_train_img,
features_query_img, ratio=0.75, method=feature_extraction_algo)

    mapped_features_image_knn = cv2.drawMatches(train_photo,
keypoints_train_img, query_photo, keypoints_query_img,
np.random.choice(matches,100),

None,flags=cv2.DrawMatchesFlags_NOT_DRAW_SINGLE_POINTS)
```

```
plt.imshow(mapped_features_image)

plt.savefig("./output/" + feature_to_match + "_matching_img_"+'.jpeg',
bbox_inches='tight',
            dpi=300, format='jpeg')
# plt.show()
```

```
Drawing: bf matched features Lines
Raw matches with Brute force): 1695
```




```
feature_to_match = 'knn'

print("Drawing: {} matched features Lines".format(feature_to_match))

fig = plt.figure(figsize=(20,8))

if feature_to_match == 'bf':
    matches = key_points_matching(features_train_img,
features_query_img, method=feature_extraction_algo)

    mapped_features_image =
cv2.drawMatches(train_photo,keypoints_train_img,query_photo,keypoints_
query_img,matches[:100],

None,flags=cv2.DrawMatchesFlags_NOT_DRAW_SINGLE_POINTS)

# Now for cross checking draw the feature-mapping lines also with KNN
elif feature_to_match == 'knn':
    matches = key_points_matching_KNN(features_train_img,
features_query_img, ratio=0.75, method=feature_extraction_algo)

    mapped_features_image_knn = cv2.drawMatches(train_photo,
keypoints_train_img, query_photo, keypoints_query_img,
np.random.choice(matches,100),
```

```
None,flags=cv2.DrawMatchesFlags_NOT_DRAW_SINGLE_POINTS)


plt.imshow(mapped_features_image_knn)
plt.axis('off')
plt.savefig("./output/" + feature_to_match + "_matching_img_"+'.jpeg',
bbox_inches='tight',
            dpi=300, format='jpeg')
plt.show()
```

```
Drawing: knn matched features Lines
Raw matches (knn): 3755
```

```
def homography_stitching(keypoints_train_img, keypoints_query_img,
matches, reprojThresh):
    """
    Perform homography stitching by calculating the homography matrix.
    """
    keypoints_train_img = np.float32([keypoint.pt for keypoint in
keypoints_train_img])
    keypoints_query_img = np.float32([keypoint.pt for keypoint in
keypoints_query_img])

    if len(matches) > 4:
        points_train = np.float32([keypoints_train_img[m.queryIdx] for
m in matches])
        points_query = np.float32([keypoints_query_img[m.trainIdx] for
m in matches])

        (H, status) = cv2.findHomography(points_train, points_query,
cv2.RANSAC, reprojThresh)

        return (matches, H, status)
```

```
    else:
        return None

M = homography_stitching(keypoints_train_img, keypoints_query_img,
matches, reprojThresh=4)

if M is None:
    print("Error!")

(matches, Homography_Matrix, status) = M

print(Homography_Matrix)
```

```
[[ 5.93941794e-01  1.40923719e-01  3.62585732e+02]
 [-2.86162110e-01  8.67748934e-01  7.29160128e+01]
 [-5.28716228e-04 -6.67225126e-05  1.00000000e+00]]
```

```
width = query_photo.shape[1] + train_photo.shape[1]

height = max(query_photo.shape[0], train_photo.shape[0])

result = cv2.warpPerspective(train_photo, Homography_Matrix,  (width,
height))

result[0:query_photo.shape[0], 0:query_photo.shape[1]] = query_photo

plt.figure(figsize=(20,10))
plt.axis('off')
plt.imshow(result)

imageio.imwrite("./output/horizontal_panorama_img_"+'.jpeg', result)

plt.show()
```