LAPORAN TUGAS KECIL 2

IF2211 Strategi Algoritma

Convex Hull dengan Algoritma Divide and Conquer

oleh

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SEKOLAH TEKNIK ELEKTRO DAN INFORMATIKA

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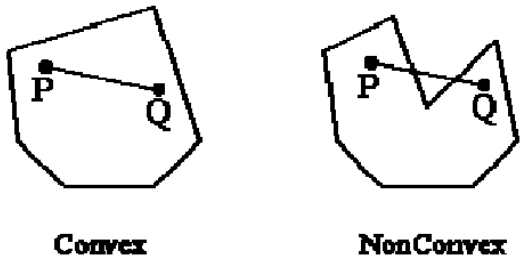
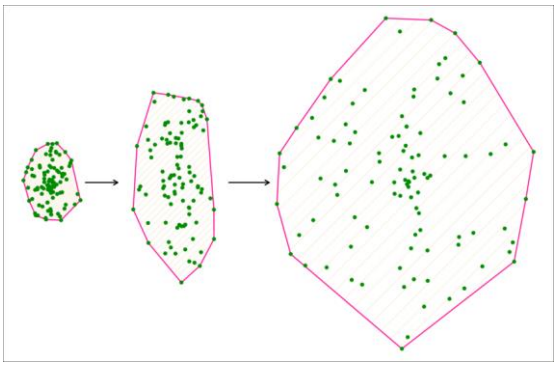
1. Algoritma Divide and Conquer untuk Convex Hull

Sebuah bidang akan disebut sebagai *convex* / konveks jika terdapat dua titik terpisah pada bidang tersebut yang jika disambungkan tidak akan keluar dari bidang. Berikut adalah ilustrasi dari bidang yang disebut konveks (*convex*).



sumber: researchgate.com

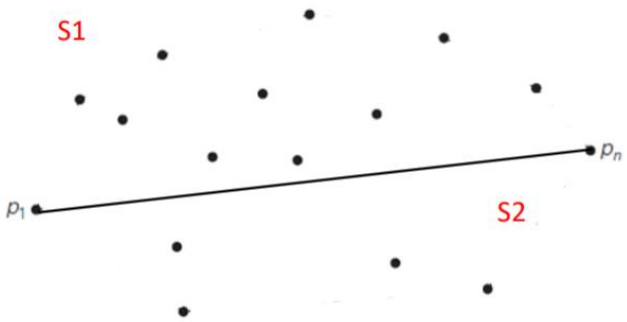
Adapun yang dimaksud dengan *Convex Hull* adalah himpunan suatu titik / *convex* terkecil yang memuat himpunan keseluruhan titik-titik. Kemudian, *Convex Hull* ini digunakan dalam beberapa aplikasi animasi komputer salah satu contohnya adalah dalam *collision detection* yang memanfaatkan *Convex Hull*.



sumber: researchgate.com

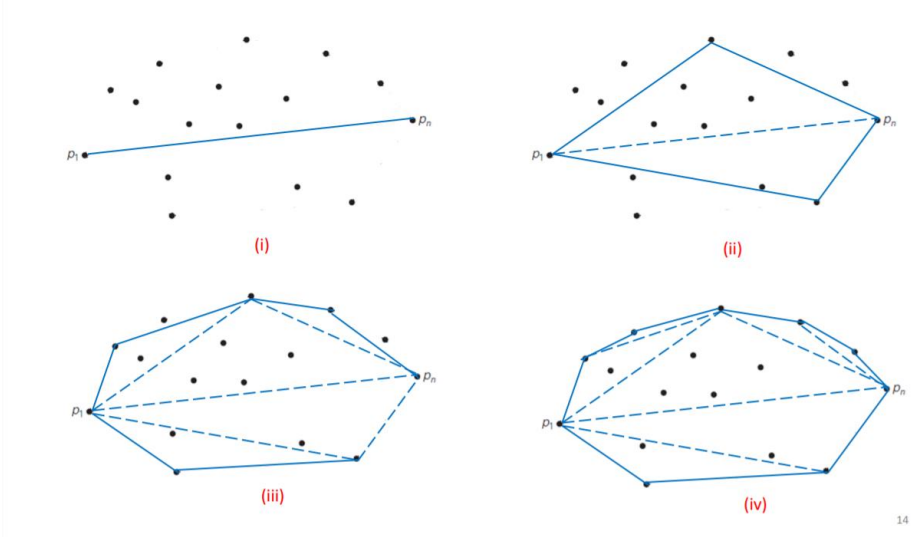
Selain pada animasi komputer, penggunaan *Convex Hull* juga dilakukan dalam bidang statistic yaitu digunakan untuk pendeteksian *outliers* yang terjadi pada beberapa kumpulan data.

Ide dari Algoritma Divide and Conquer untuk *Convex Hull* dilakukan dalam beberapa tahapan sebagai berikut:



sumber: Algoritma Divide and Conquer (2022) Bagian 4, Rinaldi Munir

1. Pertama, membagi dua bagian kumpulan titik-titik menjadi dua himpunan titik-titik yang masing-masing akan diterapkan Algoritma Divide and Conquer



sumber: Algoritma Divide and Conquer (2022) Bagian 4, Rinaldi Munir

2. Kedua, mencari titik terjauh dari masing-masing daerah (S1 dan S2) yang mungkin dari garis dari dua titik terjauh yang telah ditentukan sebelumnya, dalam hal ini adalah titik *p1* dan *pn* pada ilustrasi di atas.
3. Kemudian langkah ini akan terus diulangi dan dibagi menjadi beberapa kasus yang lebih kecil
4. Algoritma berakhir dengan penggabungan partisi-partisi yang telah dilakukan sebelumnya.

2. Source Code Algoritma Divide and Conquer untuk *Convex Hull*

A. Source Code

```
class Point:
    def __init__(self, x, y, idx):
        self.x = x
        self.y = y
        self.idx = idx

#memberikan nomor urut terhadap data yang telah diambil dari dataset Iris
def give_nomor_urut(bucket):
    point_dict = []
    for i in range (len(bucket)):
        p1 = Point(bucket[i][0], bucket[i][1], i)
        point_dict.append(p1)
    return point_dict

#mengambil area konveks sesuai dengan urutan P1-P2 (sehingga penggunaannya tinggal dibalik, jika ingin arah yang berlawanan P2-P1)
#mencari daerah S1 / S2
def area_convex(P1, P2, point_dict):
    area = []
    for i in range (len(point_dict)):
        if(point_dict[i] != P1 and point_dict[i] != P2):
            P3 = point_dict[i]
            det = P1.x*P2.y + P3.x*P1.y + P2.x*P3.y - P3.x*P2.y - P2.x*P1.y - P1.x*P3.y
            if(det < 0):
                area.append(P3)
    return area
```

```
#mencari titik paling jauh setelah mendapatkan kumpulan titik2
def far_point(P1, P2, area):
    array1 =np.array([P1.x, P1.y])
    array2 = np.array([P2.x, P2.y])
    array3 = np.array([area[0].x, area[0].y])
    max = (np.abs(np.cross(array2-array1, array1-array3)) / norm(array2-array1))
    point = area[0]
    for i in range (1, len(area)):
        array3 = np.array([area[i].x, area[i].y])
        length = (np.abs(np.cross(array2-array1, array1-array3)) / norm(array2-array1))
        if(max < length):
            max = length
            point = area[i]
    return point
```

```python
#mencari titik-titik hull yang dikelompokkan menjadi 1 array
def findHull(area, P1, P2, point_dict):
    if(len(area) == 0):
        return [[P1.idx, P2.idx]]
    elif(len(area) == 1):
        return [[P1.idx, area[0].idx], [area[0].idx, P2.idx]]
    else:
        solution = []
        far = far_point(P1, P2, area)
        area_below = area_convex(P1, far, point_dict)
        area_upper = area_convex(far, P2, point_dict)
        below_hull = findHull(area_below, P1, far, point_dict)
        upper_hull = findHull(area_upper, far, P2, point_dict)

        #tambahkan
        for i in below_hull:
            solution.append(i)
        for i in upper_hull:
            solution.append(i)
        return solution
```

```python
def myConvexHull(bucket):
    point_dict = give_nomor_urut(bucket)
    full_solution = []
    #minimum point
    P1 = point_dict[0]
    #maximum point
    P2 = point_dict[0]
    for i in range (1, len(point_dict)):
        current_point = Point(point_dict[i].x, point_dict[i].y, point_dict[i].idx)
        if(P1.x > current_point.x):
            P1 = current_point
        elif(P1.x == current_point.x):
            if(P1.y > current_point.y):
                P1 = current_point
        if(P2.x < current_point.x):
            P2 = current_point
        elif(P2.x == current_point.x):
            if(P2.y < current_point.y):
                P2 = current_point
    #atas / kiri
    left_area = area_convex(P2, P1, point_dict)

    #bawah / kanan
    right_area = area_convex(P1, P2, point_dict)

    #mencari daerah kiri/atas
    upper_solution = findHull(left_area, P2, P1, point_dict)

    #mencari daerah kanan/bawah
    bottom_solution = findHull(right_area, P1, P2, point_dict)
```

```
full_solution = []
for i in range (len(upper_solution) + len(bottom_solution)):
    if(i < len(upper_solution)):
        full_solution.append(upper_solution[i])
    elif(i >= len(upper_solution)):
        full_solution.append(bottom_solution[i-len(upper_solution)])
return full_solution
```

B. Visualisasi Data

```
data = datasets.load_iris()
#create a DataFrame
df = pd.DataFrame(data.data, columns=data.feature_names)
df['Target'] = pd.DataFrame(data.target)
print(df.shape)
df.head()

plt.figure(figsize = (10, 6))
colors = ['b','r','g']
plt.title('Sepal Width vs Sepal Length')
plt.xlabel(data.feature_names[0])
plt.ylabel(data.feature_names[1])
for i in range(len(data.target_names)):
    bucket = df[df['Target'] == i]
    bucket = bucket.iloc[:,[0,1]].values
    hull = myConvexHull(bucket)
    plt.scatter(bucket[:, 0], bucket[:, 1], label=data.target_names[i])
    for simplex in hull:
        plt.plot(bucket[simplex, 0], bucket[simplex, 1], colors[i])
    plt.legend()
plt.show()
```

Data Sepal Width and Sepal Length

```
data = datasets.load_iris()
#create a DataFrame
df = pd.DataFrame(data.data, columns=data.feature_names)
df['Target'] = pd.DataFrame(data.target)
print(df.shape)
df.head()

plt.figure(figsize = (10, 6))
colors = ['b','r','g']
plt.title('Petal Width vs Petal Length')
plt.xlabel(data.feature_names[2])
plt.ylabel(data.feature_names[3])
for i in range(len(data.target_names)):
    bucket = df[df['Target'] == i]
    bucket = bucket.iloc[:,[2,3]].values
    hull = myConvexHull(bucket)
    plt.scatter(bucket[:, 0], bucket[:, 1], label=data.target_names[i])
    for simplex in hull:
        plt.plot(bucket[simplex, 0], bucket[simplex, 1], colors[i])
    plt.legend()
plt.show()
```

Data Petal Width and Petal Length

```
data = datasets.load_wine()
#create a DataFrame
df = pd.DataFrame(data.data, columns=data.feature_names)
df['Target'] = pd.DataFrame(data.target)
print(df.shape)
df.head()

plt.figure(figsize = (10, 6))
colors = ['b','r','g']
plt.title('Malic Acid vs Alcohol')
plt.xlabel(data.feature_names[0])
plt.ylabel(data.feature_names[1])
for i in range(len(data.target_names)):
    bucket = df[df['Target'] == i]
    bucket = bucket.iloc[:,[0,1]].values
    hull = myConvexHull(bucket)
    plt.scatter(bucket[:, 0], bucket[:, 1], label=data.target_names[i])
    for simplex in hull:
        plt.plot(bucket[simplex, 0], bucket[simplex, 1], colors[i])
    plt.legend()
plt.show()
```

Data Malic Acid vs Alcohol

```
data = datasets.load_wine()
#create a DataFrame
df = pd.DataFrame(data.data, columns=data.feature_names)
df['Target'] = pd.DataFrame(data.target)
print(df.shape)
df.head()

plt.figure(figsize = (10, 6))
colors = ['b','r','g']
plt.title('Alcalinity of Ash vs Ash')
plt.xlabel(data.feature_names[2])
plt.ylabel(data.feature_names[3])
for i in range(len(data.target_names)):
    bucket = df[df['Target'] == i]
    bucket = bucket.iloc[:,[2,3]].values
    hull = myConvexHull(bucket)
    plt.scatter(bucket[:, 0], bucket[:, 1], label=data.target_names[i])
    for simplex in hull:
        plt.plot(bucket[simplex, 0], bucket[simplex, 1], colors[i])
    plt.legend()
plt.show()
```

Data Alcalinity of Ash vs Ash

```
data = datasets.load_wine()
#create a DataFrame
df = pd.DataFrame(data.data, columns=data.feature_names)
df['Target'] = pd.DataFrame(data.target)
print(df.shape)
df.head()

plt.figure(figsize = (10, 6))
colors = ['b','r','g']
plt.title('Total Phenols vs Magnesium')
plt.xlabel(data.feature_names[4])
plt.ylabel(data.feature_names[5])
for i in range(len(data.target_names)):
    bucket = df[df['Target'] == i]
    bucket = bucket.iloc[:,[4,5]].values
    hull = myConvexHull(bucket)
    plt.scatter(bucket[:, 0], bucket[:, 1], label=data.target_names[i])
    for simplex in hull:
        plt.plot(bucket[simplex, 0], bucket[simplex, 1], colors[i])
    plt.legend()
plt.show()
```

Data Total Phenols vs Magnesium

```
data = datasets.load_breast_cancer()
#create a DataFrame
df = pd.DataFrame(data.data, columns=data.feature_names)
df['Target'] = pd.DataFrame(data.target)
print(df.shape)
df.head()

plt.figure(figsize = (10, 6))
colors = ['b','r','g']
plt.title('Mean Texture vs Mean Radius')
plt.xlabel(data.feature_names[0])
plt.ylabel(data.feature_names[1])
for i in range(len(data.target_names)):
    bucket = df[df['Target'] == i]
    bucket = bucket.iloc[:,[0,1]].values
    hull = myConvexHull(bucket)
    plt.scatter(bucket[:, 0], bucket[:, 1], label=data.target_names[i])
    for simplex in hull:
        plt.plot(bucket[simplex, 0], bucket[simplex, 1], colors[i])
    plt.legend()
plt.show()
```

Data Breast Cancer Mean Texture vs Mean Radius

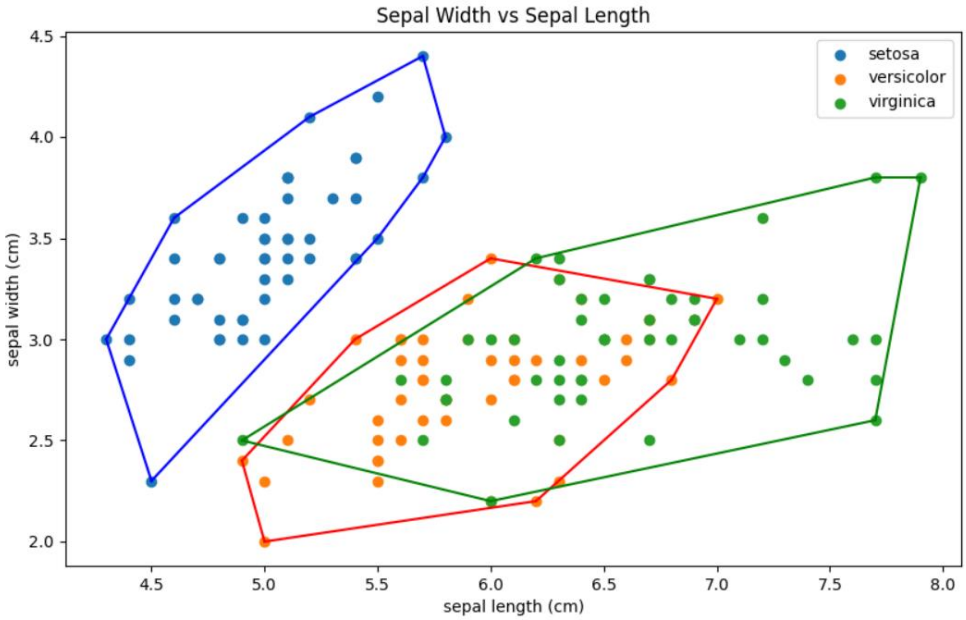
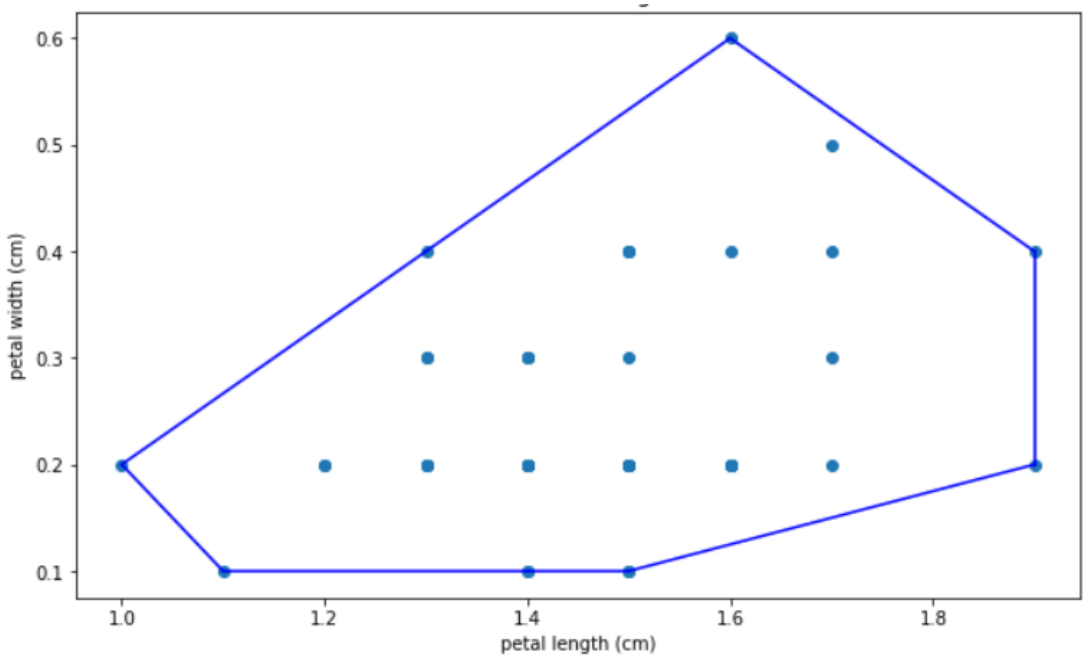
```
data = datasets.load_breast_cancer()
#create a DataFrame
df = pd.DataFrame(data.data, columns=data.feature_names)
df['Target'] = pd.DataFrame(data.target)
print(df.shape)
df.head()

plt.figure(figsize = (10, 6))
colors = ['b','r','g']
plt.title('Mean Area vs Mean Perimeter')
plt.xlabel(data.feature_names[2])
plt.ylabel(data.feature_names[3])
for i in range(len(data.target_names)):
    bucket = df[df['Target'] == i]
    bucket = bucket.iloc[:,[2,3]].values
    hull = myConvexHull(bucket)
    plt.scatter(bucket[:, 0], bucket[:, 1], label=data.target_names[i])
    for simplex in hull:
        plt.plot(bucket[simplex, 0], bucket[simplex, 1], colors[i])
    plt.legend()
plt.show()
```

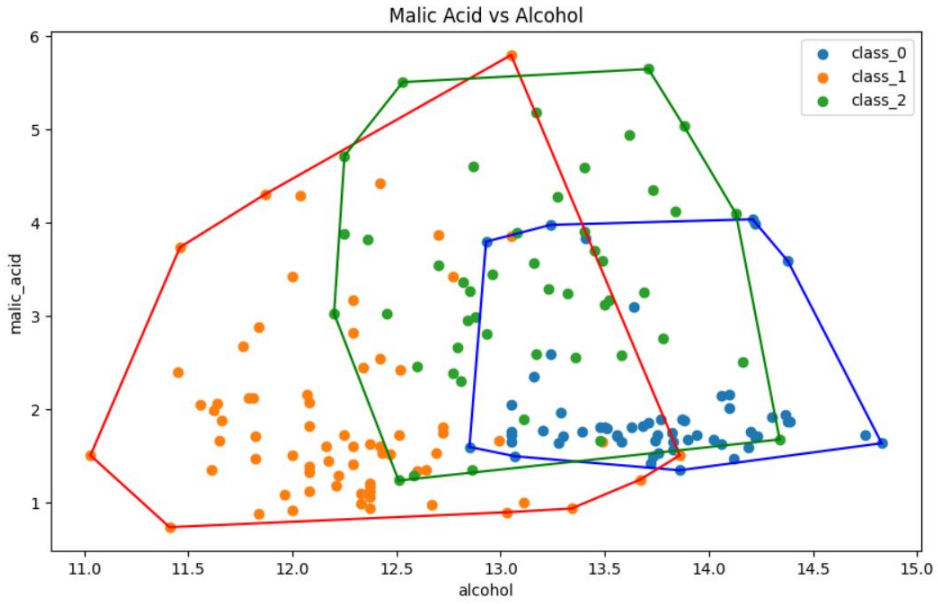
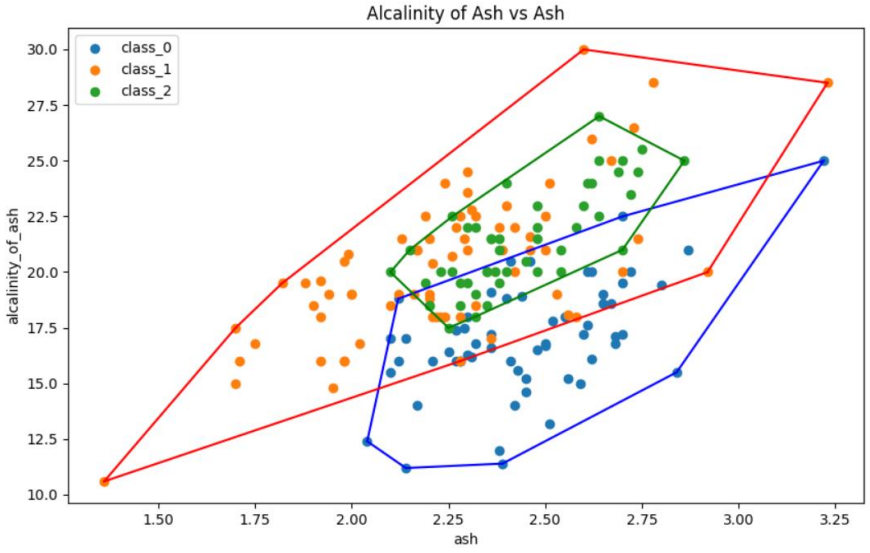
Data Breast Cancer Mean Area vs Mean Parameter

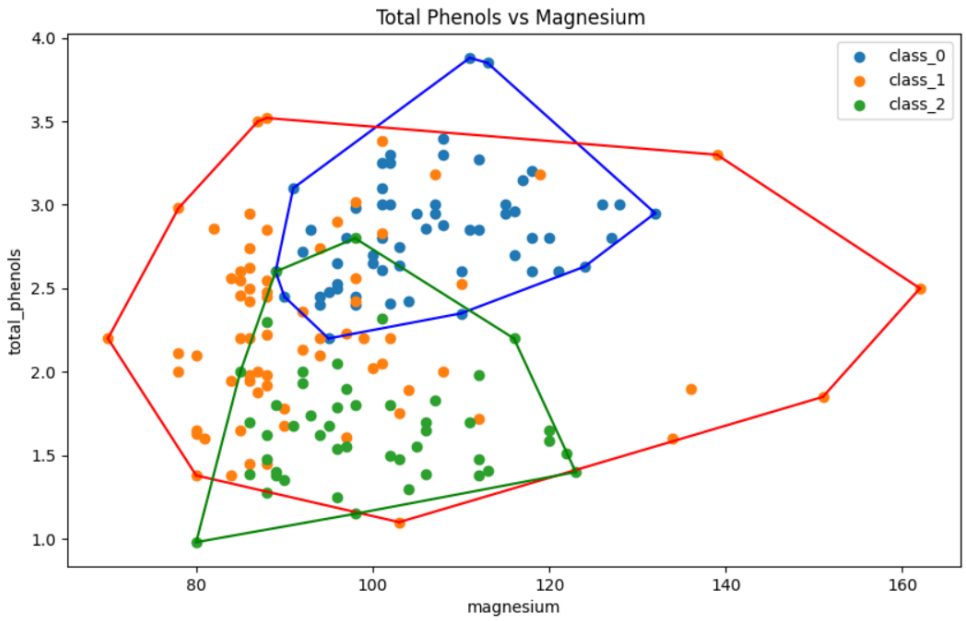
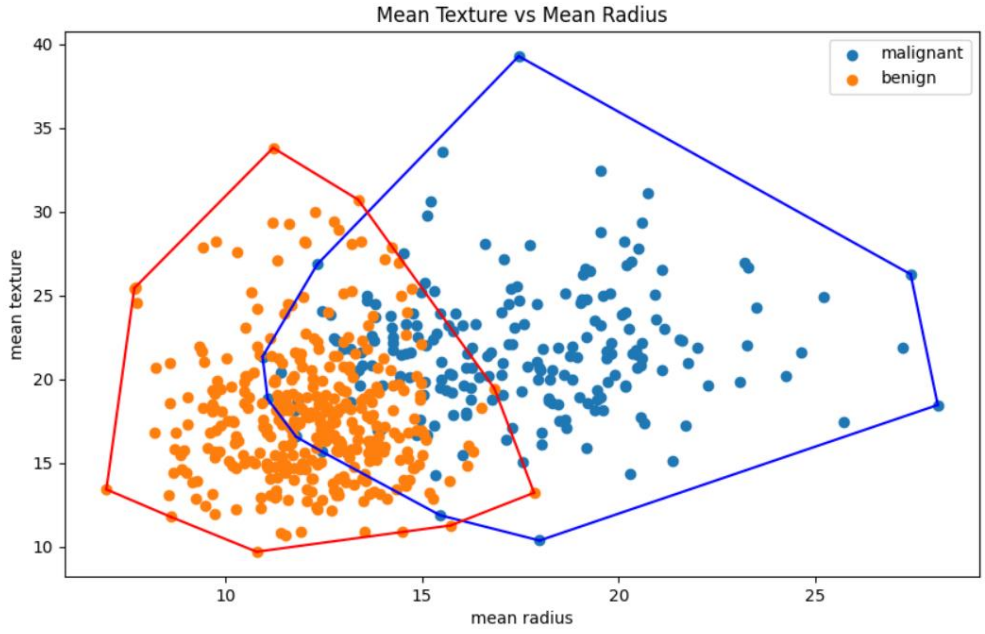
```
data = datasets.load_breast_cancer()
#create a DataFrame
df = pd.DataFrame(data.data, columns=data.feature_names)
df['Target'] = pd.DataFrame(data.target)
print(df.shape)
df.head()

plt.figure(figsize = (10, 6))
colors = ['b','r','g']
plt.title('Mean Compactness vs Mean Smoothness')
plt.xlabel(data.feature_names[4])
plt.ylabel(data.feature_names[5])
for i in range(len(data.target_names)):
    bucket = df[df['Target'] == i]
    bucket = bucket.iloc[:,[4,5]].values
    hull = myConvexHull(bucket)
    plt.scatter(bucket[:, 0], bucket[:, 1], label=data.target_names[i])
    for simplex in hull:
        plt.plot(bucket[simplex, 0], bucket[simplex, 1], colors[i])
    plt.legend()
plt.show()
```

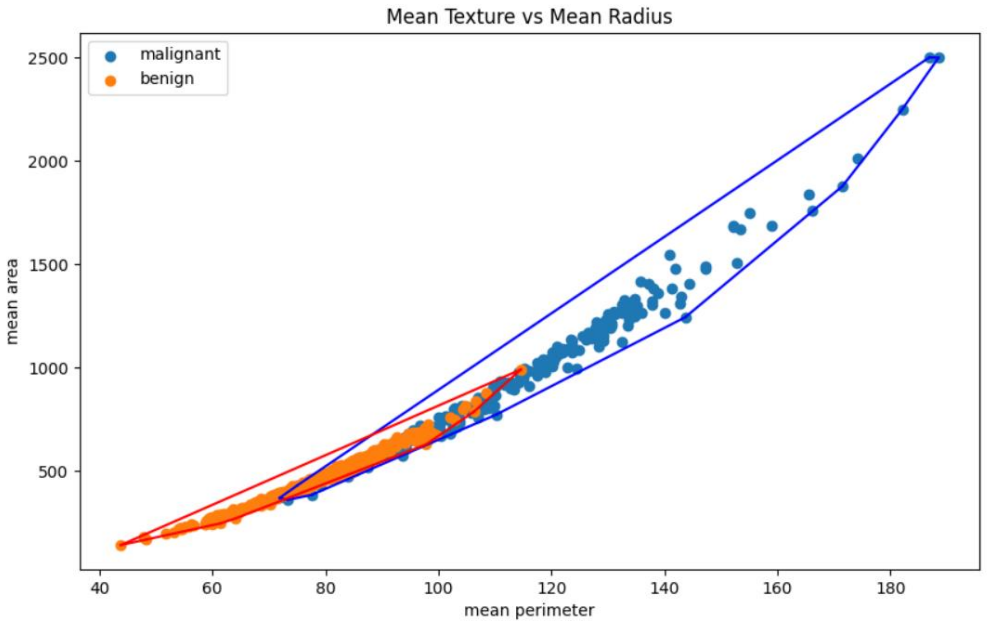
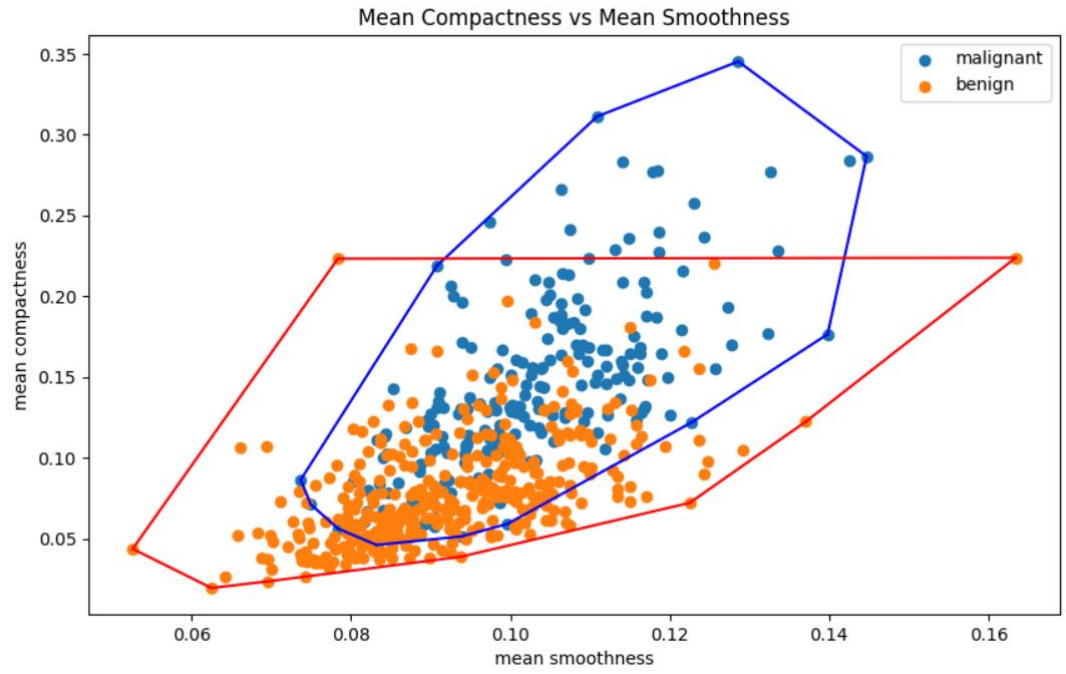
Data Breast Cancer Mean Compactness vs Mean Smoothness

3. Screenshot Pengujian Kode

No	Screenshot
1	
2	Petal error di rekursif, hanya muncul satu saja 

3	 Malic Acid vs Alcohol class_0 class_1 class_2 malic_acid alcohol 1 2 3 4 5 6 11.0 11.5 12.0 12.5 13.0 13.5 14.0 14.5 15.0
4	 Alcalinity of Ash vs Ash class_0 class_1 class_2 alcalinity_of_ash ash 10.0 12.5 15.0 17.5 20.0 22.5 25.0 27.5 30.0 1.50 1.75 2.00 2.25 2.50 2.75 3.00 3.25

5	 Total Phenols vs Magnesium class_0 class_1 class_2 total_phenols magnesium 4.0 3.5 3.0 2.5 2.0 1.5 1.0 80 100 120 140 160
6	 Mean Texture vs Mean Radius malignant benign mean texture mean radius 40 35 30 25 20 15 10 10 15 20 25

7	
8	

4. LAMPIRAN

Link github: https://github.com/KorbanFidas2A/Tucil2_13520007.git

https://github.com/KorbanFidas2A/Tucil2_13520007

Poin	Yes	No
1. Pustaka myConvexHull berhasil dibuat dan tidak ada kesalahan		√

2. Convex hull yang dihasilkan sudah benar	√	
3. Pustaka myConvexHull dapat digunakan untuk menampilkan convex hull setiap label dengan warna yang berbeda.	√	
4. Bonus: program dapat menerima input dan menuliskan output untuk dataset lainnya.	√	