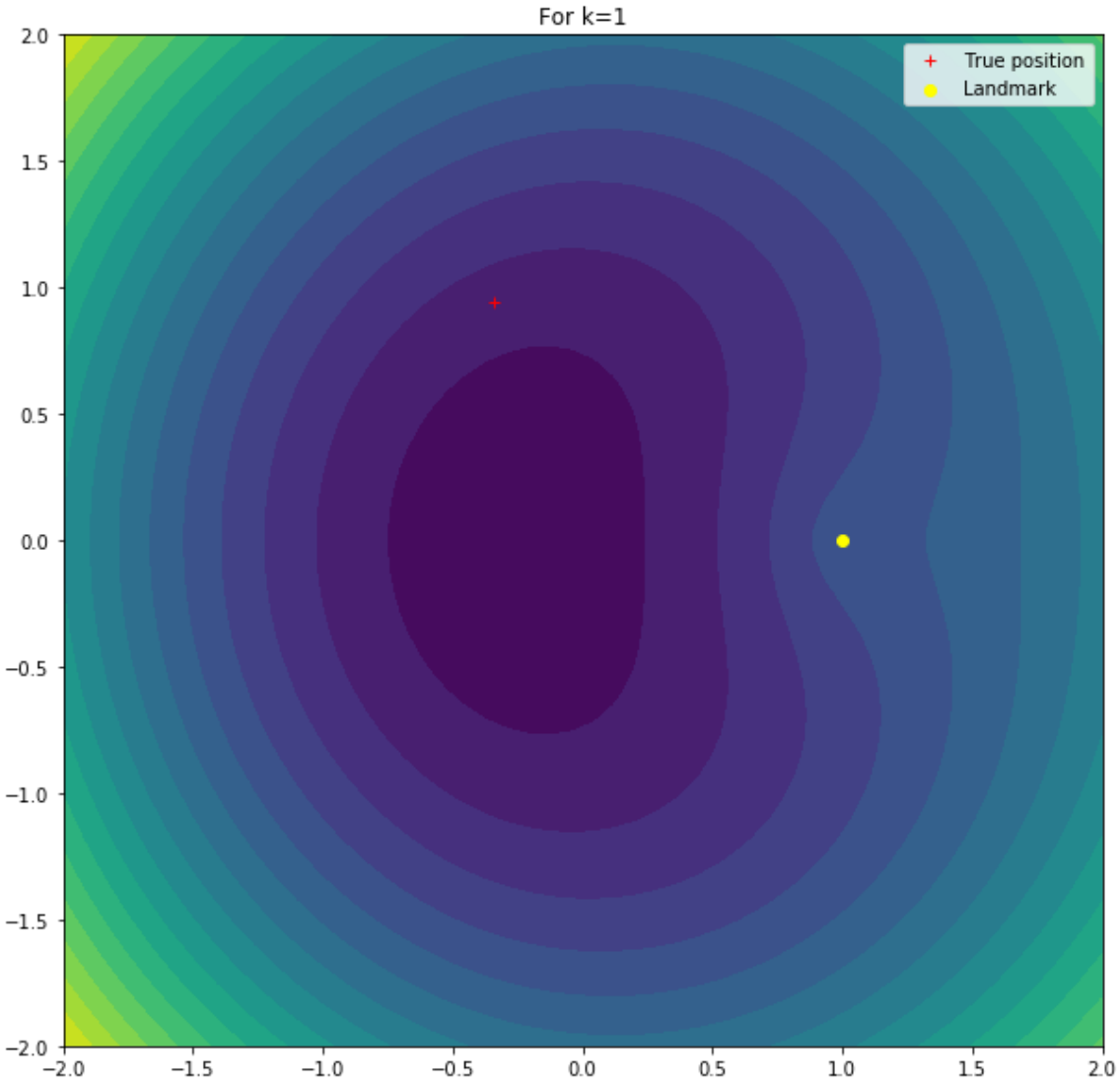
In [362]:

```
import matplotlib.pyplot as plt
import math
import random
import numpy as np
X=[]
Y=[]
D=[]
R=[]
r = 1
# center of the circle (x, y)
cx = 0
cy = 0

# random angle
alpha = np.random.uniform(0,2*math.pi,1)
xt = math.cos(alpha) + cx
yt = math.sin(alpha) + cy

k=360
for i in range(0,360,k):
    x=r*math.cos(math.radians(i))
    y=r*math.sin(math.radians(i))
    X.append(x)
    Y.append(y)
print("range= ")
for i in range(len(Y)):
    distance=math.sqrt((X[i]-xt)**2+(Y[i]-yt)**2)
    D.append(distance)
    ri=distance+np.random.normal(0,0.01,1)
    R.append(ri)
    print(ri)

sigma=np.array([0.25,0,0,0.25]).reshape(2,2)
xrand=np.linspace(-2,2,50)
yrand=np.linspace(-2,2,50)
D1=[]
ME=[]
l=[]
for i in range(len(xrand)):
    for k in range(len(yrand)):
        l.append([xrand[i],yrand[k]])

l=np.array(l)

sigma=0.3
sx=0.24
sy=0.26
ME=[]
for i in range (0,len(xrand)):
    for j in range(0,len(yrand)):
        p=0
        for k in range(len(R)):
            dist=math.sqrt((X[k]-xrand[i])**2+(Y[k]-yrand[j])**2)
            p=p+((R[k]-dist)**2)
        ME.append(((1/sigma)**2)*p+(xrand[i])**2/(sx)**2+(yrand[j])**2/(sy)**2)

xx=np.array(l[:,0]).reshape(50,50)
yy=np.array(l[:,1]).reshape(50,50)
maps=np.array(ME).reshape(50,50)
```

```
fig,ax=plt.subplots(1,1,figsize=(10,10))
contourp=ax.contourf(xx,yy,maps,levels=20)
plt.plot(xt,yt,'r+',label='True position')
plt.scatter(X,Y,color='yellow',label='Landmark')
plt.title("For k=1")
plt.legend()
plt.show()
```

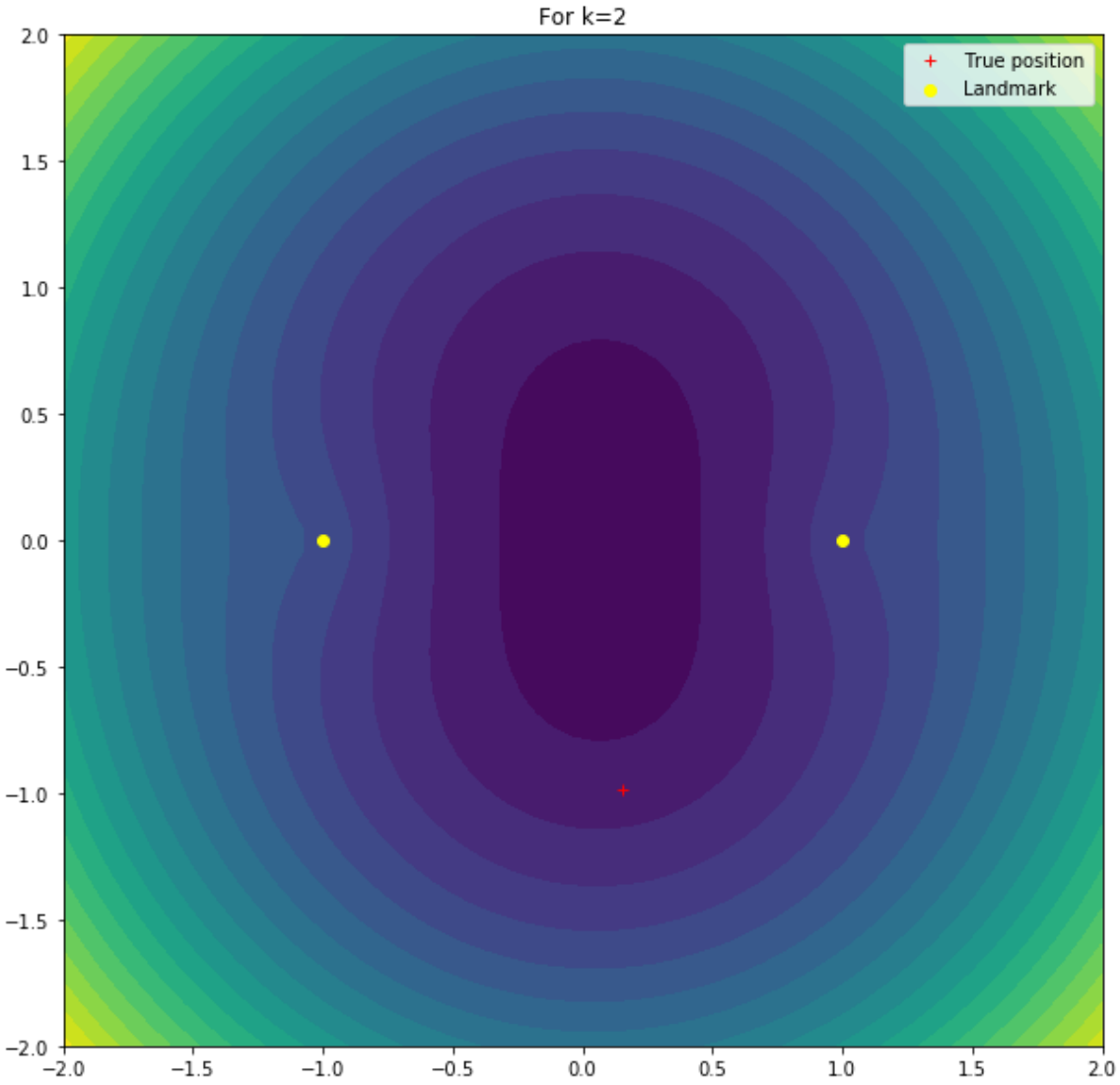
```
range=
[1.64991087]
```



In [363]:

```
X=[]
Y=[]
D=[]
R=[]
r = 1
# center of the circle (x, y)
cx = 0
cy = 0

# random angle
alpha = np.random.uniform(0,2*math.pi,1)
xt = math.cos(alpha) + cx
yt = math.sin(alpha) + cy

k=180
for i in range(0,360,k):
    x=r*math.cos(math.radians(i))
    y=r*math.sin(math.radians(i))
    X.append(x)
    Y.append(y)
print("range= ")
for i in range(len(Y)):
    distance=math.sqrt((X[i]-xt)**2+(Y[i]-yt)**2)
    D.append(distance)
    ri=distance+np.random.normal(0,0.01)
    R.append(ri)
    print(ri)


D1=[]
ME=[]
l=[]
for i in range(len(xrand)):
    for k in range(len(yrand)):
        l.append([xrand[i],yrand[k]])

l=np.array(l)


for i in range (0,len(xrand)):
    for j in range(0,len(yrand)):
        p=0
        for k in range(len(R)):
            dist=math.sqrt((X[k]-xrand[i])**2+(Y[k]-yrand[j])**2)
            p=p+((R[k]-dist)**2)
        ME.append(((1/sigma)**2)*p+(xrand[i])**2/(sx)**2+(yrand[j])**2/(sy)**2)

xx=np.array(l[:,0]).reshape(50,50)
yy=np.array(l[:,1]).reshape(50,50)
maps=np.array(ME).reshape(50,50)
fig,ax=plt.subplots(1,1,figsize=(10,10))
contourp=ax.contourf(xx,yy,maps,levels=20)
plt.plot(xt,yt,'r+',label='True position')
plt.scatter(X,Y,color='yellow',label='Landmark')
plt.title("For k=2")
plt.legend()
plt.show()
```

```
range=
1.2911424932923092
1.5274060599820134
```

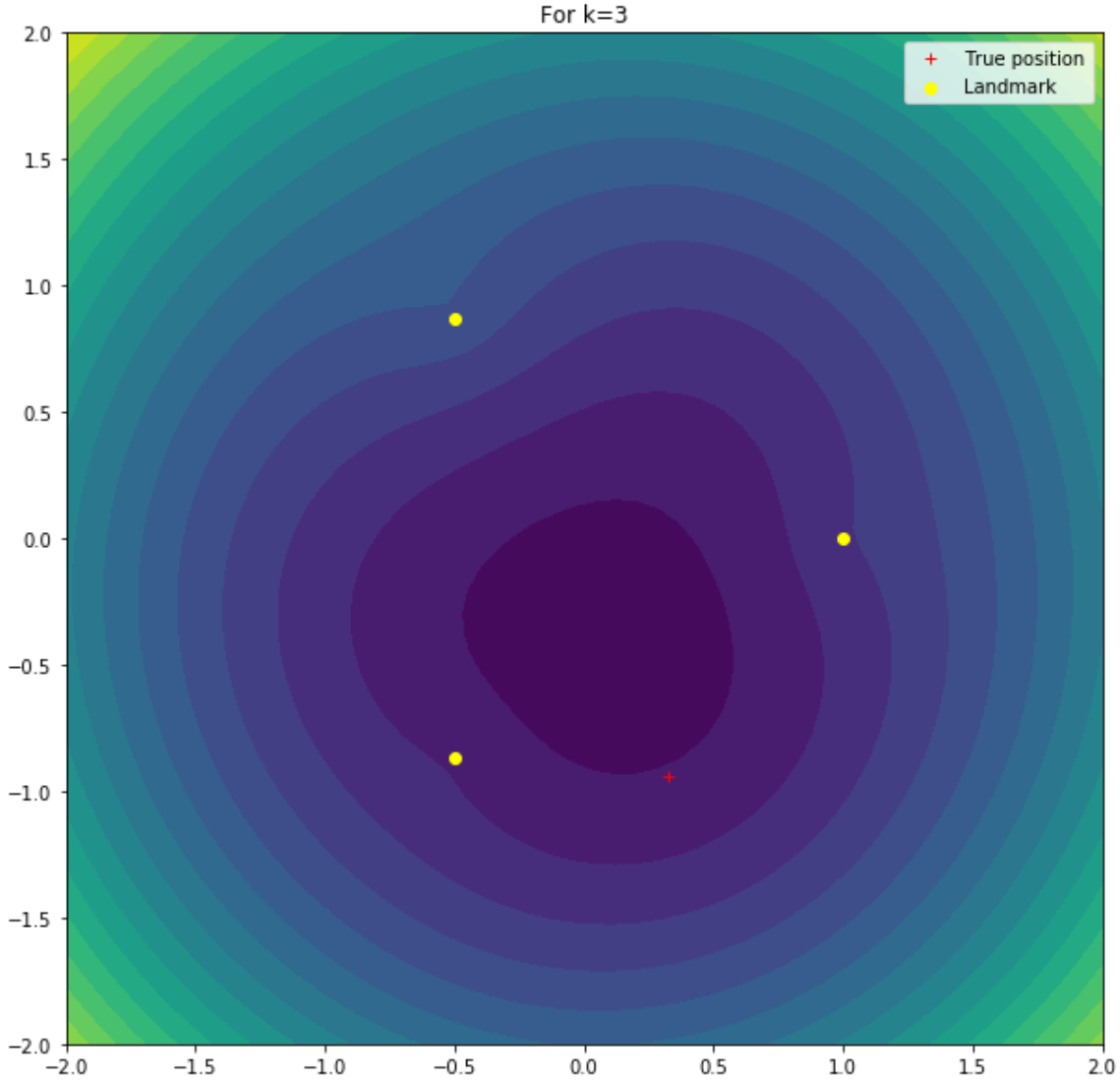


In [366]:

```
import matplotlib.pyplot as plt
import math
import random
import numpy as np
X=[]
Y=[]
D=[]
R=[]
cr = 1
# center of the circle (x, y)
cx = 0
cy = 0

# random angle
alpha = np.random.uniform(0,2*math.pi,1)
# random radius
# r = circle_r
# calculating coordinates
# alpha = 2*(math.pi*1)/3

xt = math.cos(alpha) + cx
yt = math.sin(alpha) + cy

k=120
for i in range(0,360,k):
    x=r*math.cos(math.radians(i))
    y=r*math.sin(math.radians(i))
    X.append(x)
    Y.append(y)
print("range= ")
for i in range(len(Y)):
    distance=math.sqrt((X[i]-xt)**2+(Y[i]-yt)**2)
    D.append(distance)
    ri=distance+np.random.normal(0,0.01)
    R.append(ri)
    print(ri)
xrand=np.linspace(-2,2,50)
yrand=np.linspace(-2,2,50)
D1=[]
ME=[]
l=[]
for i in range(len(xrand)):
    for k in range(len(yrand)):
        l.append([xrand[i],yrand[k]])

l=np.array(l)
sigma=0.3
sigmax=0.23 #according to the question
sigmay=0.25 #according to the question
ME=[]#storing all the mapestimate values in this list
for i in range (0,len(xrand)):
    for j in range(0,len(yrand)):
        kkk=0
        for k in range(len(R)):
            dist=math.sqrt((X[k]-xrand[i])**2+(Y[k]-yrand[j])**2)
            kkk=kkk+((R[k]-dist)**2)
        ME.append(((1/sigma)**2)*kkk+(xrand[i])**2/(sigmax)**2+(yrand[j])**2/(sigmay)**
2)
```

```
xx=np.array(l[:,0]).reshape(50,50)
yy=np.array(l[:,1]).reshape(50,50)
maps=np.array(ME).reshape(50,50)
fig,ax=plt.subplots(1,1,figsize=(10,10))
contourp=ax.contourf(xx,yy,maps,levels=20)
plt.plot(xt,yt,'r+',label='True position')
plt.scatter(X,Y,label='Landmark',color="yellow")
plt.title("For k=3")
plt.legend()
plt.show()
```

```
range=
1.1453339200270236
1.9759917406204452
0.8034921081004356
```

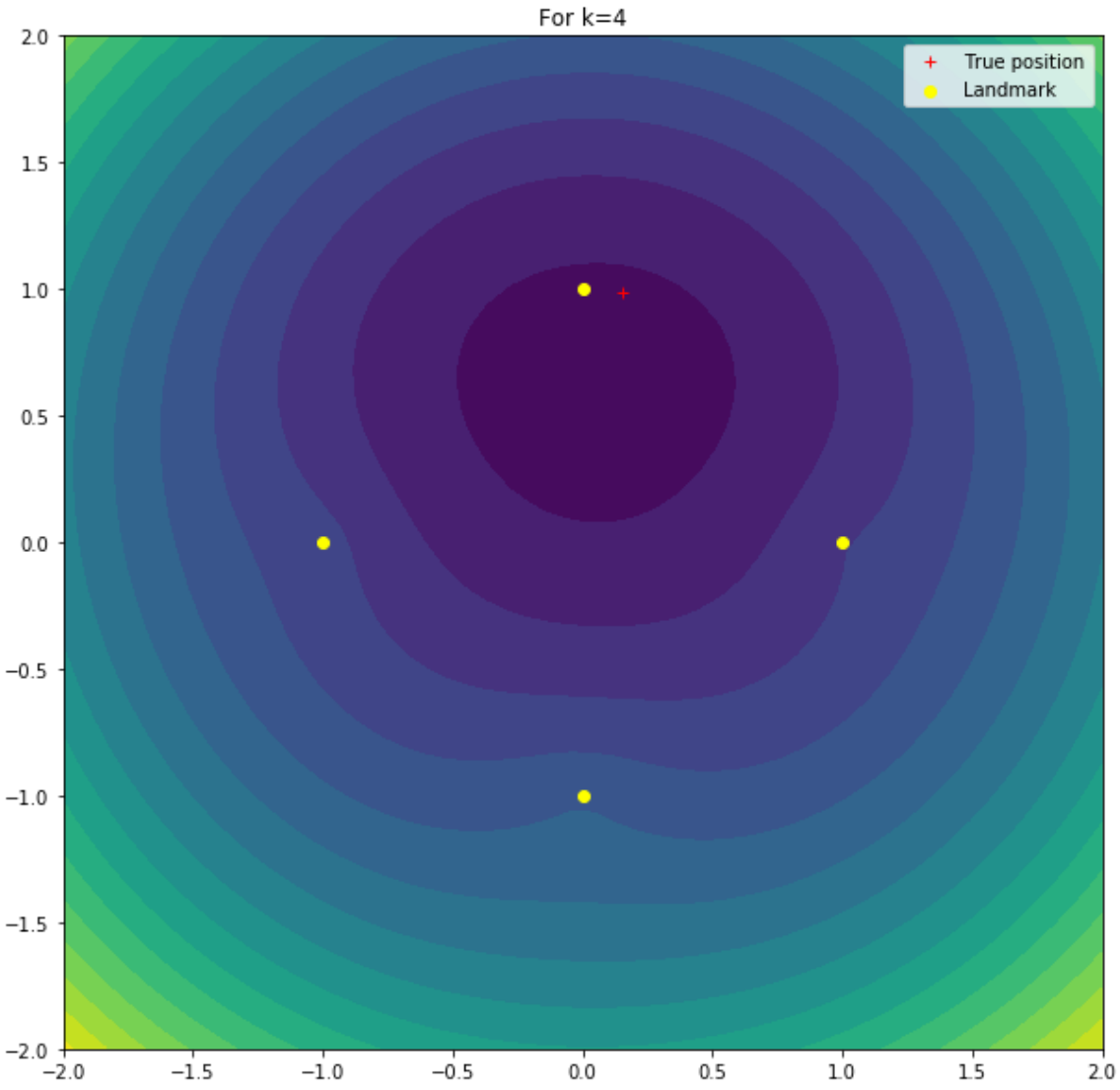


In [382]:

```
X=[]
Y=[]
D=[]
R=[]
r = 1
# center of the circle (x, y)
cx = 0
cy = 0

# random angle
alpha = np.random.uniform(0,2*math.pi,1)
xt = math.cos(alpha) + cx
yt = math.sin(alpha) + cy

k=90
for i in range(0,360,k):
    x=r*math.cos(math.radians(i))
    y=r*math.sin(math.radians(i))
    X.append(x)
    Y.append(y)
print("range= ")
for i in range(len(Y)):
    distance=math.sqrt((X[i]-xt)**2+(Y[i]-yt)**2)
#     print(distance)
    D.append(distance)
    ri=distance+np.random.normal(0,0.01)
    R.append(ri)
    print(ri)

sigma=np.array([0.25,0,0,0.25]).reshape(2,2)
xrand=np.linspace(-2,2,50)
yrand=np.linspace(-2,2,50)
D1=[]
ME=[]
l=[]
for i in range(len(xrand)):
    for k in range(len(yrand)):
        l.append([xrand[i],yrand[k]])

l=np.array(l)

sigma=0.3
sx=0.25
sy=0.25
ME=[]
for i in range (0,len(xrand)):
    for j in range(0,len(yrand)):
        p=0
        for k in range(len(R)):
            dist=math.sqrt((X[k]-xrand[i])**2+(Y[k]-yrand[j])**2)
            p=p+((R[k]-dist)**2)
        ME.append(((1/sigma)**2)*p+(xrand[i])**2/(sx)**2+(yrand[j])**2/(sy)**2)

xx=np.array(l[:,0]).reshape(50,50)
yy=np.array(l[:,1]).reshape(50,50)
maps=np.array(ME).reshape(50,50)
fig,ax=plt.subplots(1,1,figsize=(10,10))
contourp=ax.contourf(xx,yy,maps,levels=20)
plt.plot(xt,yt,'r+',label='True position')
```

```
plt.scatter(X,Y,label='Landmark',color='yellow')
plt.title("For k=4")
plt.legend()
plt.show()
```

```
range=
1.3064309072183458
0.1541111949608576
1.5110348208777904
1.9979254893886225
```



In [ ]: