Overampling with SMOTE with its relative algogithms

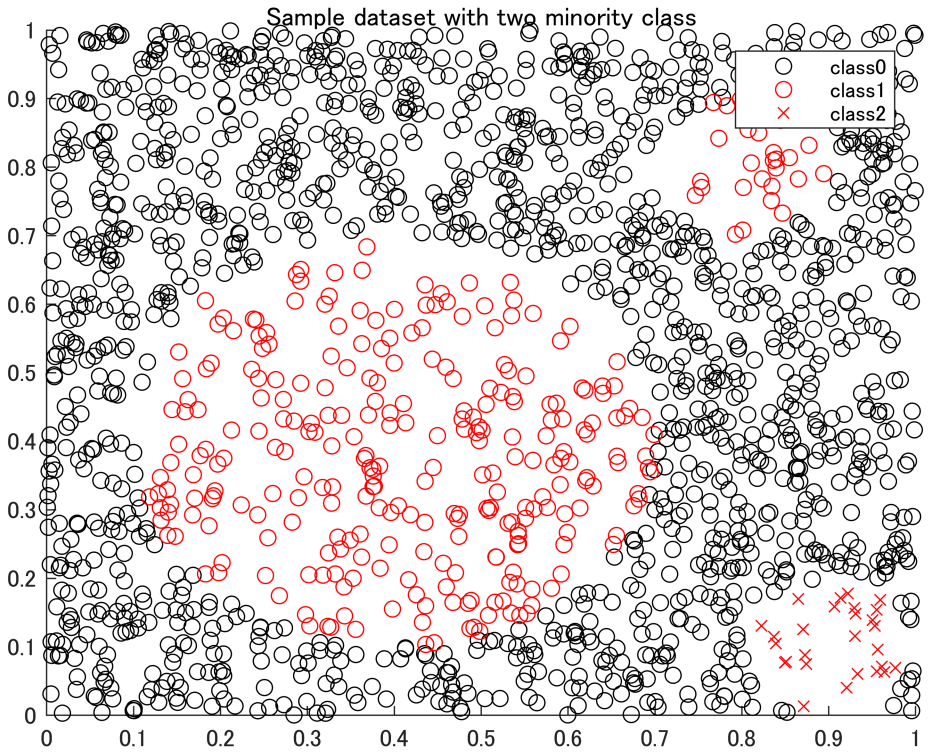
- SMOTE (Chawla, NV. et al. 2002)[1]
- Borderline SMOTE (Han, H. et al. 2005)[2]
- ADASYN (He, H. et al. 2008)[3]
- Safe-level SMOTE (Bunkhumpornpat, C. at al. 2009)[4]

Creating sample data

```
clear;
close all;
addpath('./functions');

Ndata = 2000;
data = rand(Ndata,2);

x = data(:,1);
y = data(:,2);
```

Define the two minority class in three circles.

```
% center = (0.4,0.4), radius = 0.3
idx1a = (x-0.4).^2 + (y-0.4).^2 < 0.3^2;
% center = (0.8,0.8), radius = 0.1
idx1b = (x-0.8).^2 + (y-0.8).^2 < 0.1^2;
% center = (0.9,0.1), radius = 0.1
idx2 = (x-0.9).^2 + (y-0.1).^2 < 0.1^2;

% decrease the number of samples for two minority class
undersampleRate = 2; % Undersample rate
data1 = data(idx1a|idx1b,:);
data1 = data1(1:undersampleRate:end,:);
data2 = data(idx2,:);
data2 = data2(1:undersampleRate:end,:);

% delete those from the original datset
data(idx1a|idx1b|idx2,:) = [];

% plot
figure(1)
scatter(data(:,1),data(:,2),'black','o');
hold on
scatter(data1(:,1),data1(:,2),'red','o');
scatter(data2(:,1),data2(:,2),'red','x');
hold off
title("Sample dataset with two minority class")
legend("class0","class1","class2")
```



Check the number of data for each class

```
label0 = repmat("class0",length(data),1);
label1 = repmat("class1",length(data1),1);
label2 = repmat("class2",length(data2),1);

dataset = array2table([data;data1;data2]);
dataset = addvars(dataset, [label0;label1;label2],...
    'NewVariableNames','label');
labels = dataset(:,end);
t = tabulate(dataset.label)
```

t = 3×3 cell

	1	2	3
1	'class0'	1352	80.6202
2	'class1'	298	17.7698
3	'class2'	27	1.6100

```
uniqueLabels = string(t(:,1));
labelCounts = cell2mat(t(:,2));
```

Synthesize data

Define the number of data point to synthesize and algorithms to use.

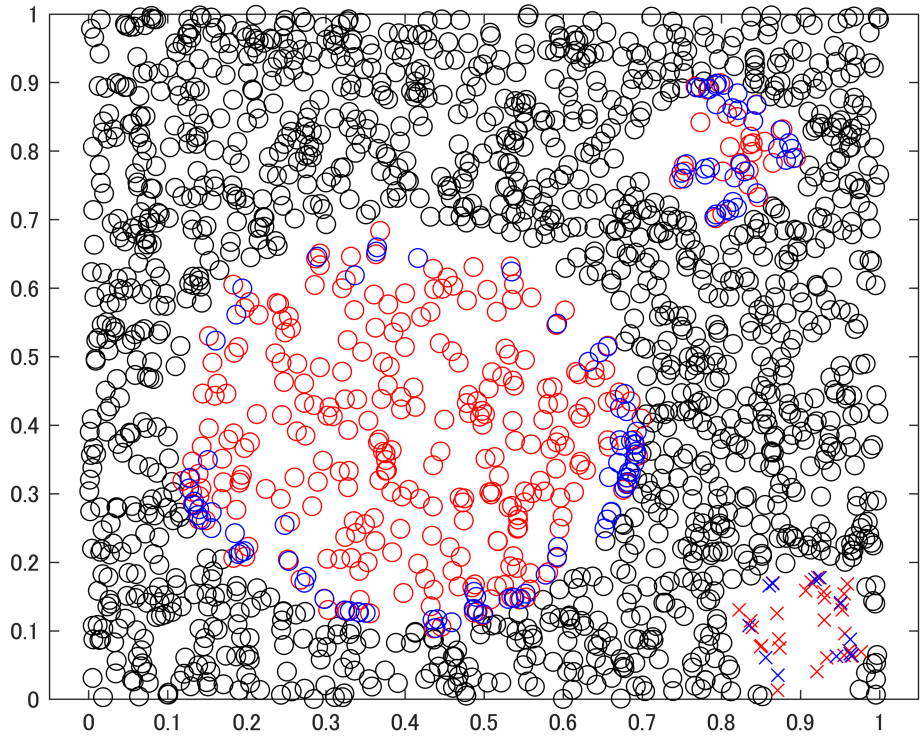
```
N2generate = [0,100,10];
algorithm = "ADASYN";
```

Defile the number of neighbors to use

```
k = 5;
newdata = table;
visdataset = cell(length(uniqueLabels),1);

% for each class
for ii=1:length(uniqueLabels)
    switch algorithm
        case "SMOTE"
            [tmp,visdata] = mySMOTE(dataset,uniqueLabels(ii),N2generate(ii),k);
        case "ADASYN"
            [tmp,visdata]  = myADASYN(dataset,uniqueLabels(ii),N2generate(ii),k);
        case "Borderline SMOTE"
            [tmp,visdata] = myBorderlineSMOTE(dataset,uniqueLabels(ii),N2generate(ii),k);
        case "Safe-level SMOTE"
            [tmp,visdata] = mySafeLevelSMOTE(dataset,uniqueLabels(ii),N2generate(ii),k);
    end
    newdata = [newdata; tmp];
    visdataset{ii} = visdata;
end
```

Visualize results

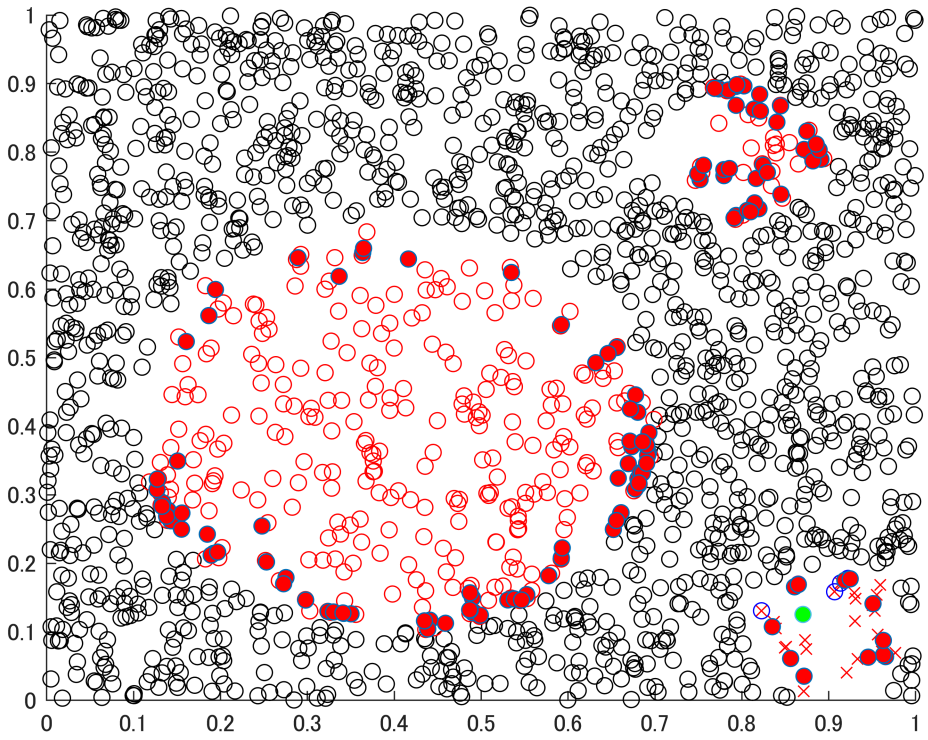
```
figure(2)
gscatter(dataset.Var1,dataset.Var2,dataset.label,'krr','oox',7,'off');
hold on
gscatter(newdata.Var1,newdata.Var2,newdata.label,'bb','ox',7,'off');
hold off
```



Visualize the results in animation

```
figure(3)
% original dataset
scatter(data(:,1),data(:,2),'black','o');
hold on
scatter(data1(:,1),data1(:,2),'red','o');
scatter(data2(:,1),data2(:,2),'red','x');
% objects to show the process
% a data from the original data
hl1 = plot(0,0,'LineStyle','none','Marker','o','MarkerFaceColor','b');
% all neighboring points
hl2 = plot(0,0,'LineStyle','none','Marker','o','MarkerEdgeColor','b');
% a neighboring point to use for synthesize new data
hl3 = plot(0,0,'LineStyle','none','Marker','o','MarkerFaceColor','g');
% a synthesized data
hl4 = plot(0,0,'LineStyle','none','Marker','o','MarkerFaceColor','y');

if exist('hl5',"var")
    clear hl5;
end
for ii=1:length(uniqueLabels)
    visdata = visdataset{ii};
    if length(visdata) == 1
        continue
    end
    for jj=1:length(visdata)
```

```
        % 1: y, 2: nnarray, 3: y2, 4: synthetic data
        y = visdata{jj,1};
        yknn = visdata{jj,2};
        y2 = visdata{jj,3};
        newy = visdata{jj,4};

        hl1.XData = y(1);
        hl1.YData = y(2);
        hl2.XData = yknn(:,1);
        hl2.YData = yknn(:,2);
        hl3.XData = y2(1);
        hl3.YData = y2(2);
        hl4.XData = newy(1);
        hl4.YData = newy(2);

        if exist('hl5',"var")
            hl5.XData = [hl5.XData,newy(1)];
            hl5.YData = [hl5.YData,newy(2)];
        else
            hl5 = plot(newy(1),newy(2),'LineStyle','none',...
                'Marker','o','MarkerFaceColor','r');
        end

        drawnow
        pause(0.3)
    end
end
hold off
```



Reference

[1]: Chawla, N. V., Bowyer, K. W., Hall, L. O., & Kegelmeyer, W. P. (2002). SMOTE: synthetic minority over-sampling technique. Journal of artificial intelligence research, 16, 321-357.

[2]: Han, H., Wang, W. Y., & Mao, B. H. (2005). Borderline-SMOTE: a new over-sampling method in imbalanced data sets learning. In International conference on intelligent computing (pp. 878-887). Springer, Berlin, Heidelberg.

[3]: He, H., Bai, Y., Garcia, E. A., & Li, S. (2008). ADASYN: Adaptive synthetic sampling approach for imbalanced learning. In 2008 IEEE International Joint Conference on Neural Networks (pp. 1322-1328). IEEE.

[4]: Bunkhumpornpat, C., Sinapiromsaran, K., & Lursinsap, C. (2009). Safe-level-smote: Safe-level-synthetic minority over-sampling technique for handling the class imbalanced problem. In Pacific-Asia conference on knowledge discovery and data mining (pp. 475-482). Springer, Berlin, Heidelberg.