Part f)

i)

```matlab
Cat=["emu" "flamingo"];
for k=1:numel(Cat)
    Directory=[char(Cat(k)) '\'];
    Names1=dir(['101_ObjectCategories\' Directory]);
    Names1(1:2)=[];
    Names2=dir(['Annotations\' Directory]);
    Names2(1:2)=[];
    F_train=nan(floor(numel(Names1)*.9),106);
    y_train=cell(size(F_train,1),1);
    F_test=nan(numel(Names1)-size(F_train,1),106);
    y_test=cell(size(F_test,1),1);
    for i=1:size(F_train,1)
        im=double(imread([cd '\101_ObjectCategories\' Directory Names1(i).name]))/255;
        [M,N,~]=size(im);
        ann=load([cd '\Annotations\' Directory Names2(i).name]);
        mask=double(poly2mask(ann.obj_contour(1,:)+ann.box_coord(3),ann.obj_contour(2,:)+ann.box_coord(1),M,N));
        F_train(i,1:30)=extract_color_features(im*255,mask);
        F_train(i,31:40)=extract_boundary_features(mask);
        F_train(i,41:47)=extract_hu_moments(mask);
        F_train(i,48:58)=extract_props(mask);
        F_train(i,59:end)=extract_texture_features(im,mask);
        y_train{i}=Directory(1:end-1);
    end
    for j=i+1:numel(Names1)
        im=double(imread([cd '\101_ObjectCategories\' Directory Names1(j).name]))/255;
        [M,N,~]=size(im);
        ann=load([cd '\Annotations\' Directory Names2(j).name]);
        mask=double(poly2mask(ann.obj_contour(1,:)+ann.box_coord(3),ann.obj_contour(2,:)+ann.box_coord(1),M,N));
        F_test(j-i,1:30)=extract_color_features(im*255,mask);
        F_test(j-i,31:40)=extract_boundary_features(mask);
        F_test(j-i,41:47)=extract_hu_moments(mask);
        F_test(j-i,48:58)=extract_props(mask);
        F_test(j-i,59:end)=extract_texture_features(im,mask);
        y_test{j-i}=Directory(1:end-1);
    end
    disp(['First column of F_test for ' char(Cat(k))])
    format shortE
    disp(F_test(:,1)')
    disp(['y_test for ' char(Cat(k))])
    disp(y_test')
end
```

```
 First column of F_test for emu
    1.2327e+02    8.0304e+01    1.2023e+02    1.0076e+02    1.3924e+02    1.0839e+02
 y_test for emu
     'emu'    'emu'    'emu'    'emu'    'emu'    'emu'
 First column of F_test for flamingo
    1.4755e+02    2.0279e+02    1.4585e+02    1.8673e+02    1.5556e+02    1.2390e+02    2.1009e+02
 y_test for flamingo
     'flamingo'    'flamingo'    'flamingo'    'flamingo'    'flamingo'    'flamingo'    'flamingo'
```

ii)

```matlab
%function [F_norm,mx,mn]=normalize_feature_columns(F,varargin)
switch nargin
    case 1
        mn=min(F);
```

```matlab
        mx=max(F-repmat(mn,size(F,1),1));
        mx(mx==0)=1;
        F_norm=(F-repmat(mn,size(F,1),1))./repmat(mx,size(F,1),1);
    case 3
        F_norm=(F-repmat(varargin{2},size(F,1),1))./repmat(varargin{1},size(F,1),1);
    otherwise
        disp('Wrong function definition!')
end
%end
```

```matlab
% using the functionabove,results are calculated and printed
Cat=["emu" "flamingo"];
for k=1:numel(Cat)
    Directory=[char(Cat(k)) '\'];
    Names1=dir(['101_ObjectCategories\' Directory]);
    Names1(1:2)=[];
    Names2=dir(['Annotations\' Directory]);
    Names2(1:2)=[];
    F_train=nan(floor(numel(Names1)*.9),106);
    y_train=cell(size(F_train,1),1);
    F_test=nan(numel(Names1)-size(F_train,1),106);
    y_test=cell(size(F_test,1),1);
    for i=1:size(F_train,1)
        im=double(imread([cd '\101_ObjectCategories\' Directory Names1(i).name]))/255;
        [M,N,~]=size(im);
        ann=load([cd '\Annotations\' Directory Names2(i).name]);
        mask=double(poly2mask(ann.obj_contour(1,:)+ann.box_coord(3),ann.obj_contour(2,:)+ann.box_coord(1),M,N));
        F_train(i,1:30)=extract_color_features(im*255,mask);
        F_train(i,31:40)=extract_boundary_features(mask);
        F_train(i,41:47)=extract_hu_moments(mask);
        F_train(i,48:58)=extract_props(mask);
        F_train(i,59:end)=extract_texture_features(im,mask);
        y_train{i}=Directory(1:end-1);
    end
    for j=i+1:numel(Names1)
        im=double(imread([cd '\101_ObjectCategories\' Directory Names1(j).name]))/255;
        [M,N,~]=size(im);
        ann=load([cd '\Annotations\' Directory Names2(j).name]);
        mask=double(poly2mask(ann.obj_contour(1,:)+ann.box_coord(3),ann.obj_contour(2,:)+ann.box_coord(1),M,N));
        F_test(j-i,1:30)=extract_color_features(im*255,mask);
        F_test(j-i,31:40)=extract_boundary_features(mask);
        F_test(j-i,41:47)=extract_hu_moments(mask);
        F_test(j-i,48:58)=extract_props(mask);
        F_test(j-i,59:end)=extract_texture_features(im,mask);
        y_test{j-i}=Directory(1:end-1);
    end
    [Fn_train,mx,mn]=normalize_feature_columns(F_train);
    disp(['every tenth entry in mx for ' char(Cat(k))])
    disp(mx(1:10:61))
    disp(mx(71:10:end))
    disp(['every tenth entry in mn for ' char(Cat(k))])
    disp(mn(1:10:61))
     disp(mx(71:10:end))
    Fn_test=normalize_feature_columns(F_test,mx,mn);
    disp(['First column of Fn_test for ' char(Cat(k))])
    disp(Fn_test(:,1)')
end
```

```
  every tenth entry in mx for emu
        122.06        125.25       0.59417     1.6776e+06       0.12908         166.52       0.043562
       0.34024        9.2124       0.59742        0.3499
  every tenth entry in mn for emu
```

```
      59.251         46.474              0   7.9382e+05        0.20012         71.302      0.0015958
     0.34024         9.2124        0.59742         0.3499
First column of Fn_test for emu
     0.52446        0.17248        0.49963        0.34007         0.6553        0.40257
every tenth entry in mx for flamingo
      138.29         141.52        0.55104   2.4239e+06        0.49006         127.14       0.034502
     0.40597         17.677        0.63795        0.46705
every tenth entry in mn for flamingo
      83.244         54.704        0.11089   6.7491e+05        0.18267         64.129      0.0021938
     0.40597         17.677        0.63795        0.46705
First column of Fn_test for flamingo
     0.46497        0.86447        0.45272        0.74829        0.52291        0.29397        0.91722
```