HMIS-1 Dataset Classification

```
%% Read the Data and Preprocess

>> VarNames = {'CCR6','CD19','CKIT','CD11b','CD4','CD8a', ...
   'CD7','CD25','CD123','TCRgd','CD45','CRTH2','CD122', ...
   'CCR7','CD14','CD11c','CD161','CD127','CD8b','CD27', ...
   'IL-15Ra','CD45RA','CD3','CD28','CD38','NKp46','PD-1','CD56'};

>> Samples_Tag = [cellstr(repmat('CeD',4,1)); ...
   cellstr(repmat('Ctrl',7,1)); cellstr(repmat('CeD',9,1));...
   cellstr(repmat('Ctrl',7,1)); cellstr(repmat('RCDII',6,1));...
   cellstr(repmat('CD',14,1))];

>> SamplesData=struct('Data',[],'Labels',{});
>> H=dir(fullfile('Samples\', '*.csv'));
>> SamplesFiles = cellstr(char(H(1:end).name));

>> H=dir(fullfile('Labels\', '*.csv'));
>> LabelsFiles = cellstr(char(H(1:end).name));
>> clear H

>> for i=1:length(SamplesFiles)
>>     SamplesData(i).Data = csvread(['Samples\' SamplesFiles{i}]);
>>     SamplesData(i).Labels = table2cell(readtable(['Labels\'...
       LabelsFiles{i}],'ReadVariableNames',0,'Delimiter',','));
>> end
>> clear i SamplesFiles LabelsFiles

>> Labels = [];
>> for i=1:length(SamplesData)
>>     Labels = [Labels; SamplesData(i).Labels];
>> end
>> CellTypes = unique(Labels);
>> CellTypes(strcmp('Discard',CellTypes)) = [];
>> clear i Labels

% Data is already arcsinh(5) transformed

%% run LDA Classifier with 3-fold cross-validation on samples

>> CVO = cvpartition(1:1:length(SamplesData),'k',3);
>> Accuracy = zeros(length(SamplesData),1);
>> training_time = zeros(CVO.NumTestSets,1);
>> testing_time = zeros(length(SamplesData),1);
>> ConfusionMat = zeros(length(CellTypes));

>> for i = 1:CVO.NumTestSets
>>     trIdx = find(CVO.training(i));
>>     teIdx = find(CVO.test(i));

>>     DataTrain=[];
>>     LabelsTrain=[];
>>     for j=1:length(trIdx)
>>         DataTrain = [DataTrain; SamplesData(trIdx(j)).Data];
>>         LabelsTrain = [LabelsTrain;SamplesData(trIdx(j)).Labels];
>>     end
>>     clear j
>>     DataTrain(strcmp('Discard',LabelsTrain),:) = [];
>>     LabelsTrain(strcmp('Discard',LabelsTrain)) = [];

>>     tic
>>     classificationLDA = fitcdiscr(...
>>         DataTrain, ...
>>         LabelsTrain);
>>     training_time(i)=toc;          %in seconds

>>     for j=1:length(teIdx)
>>         DataTest = SamplesData(teIdx(j)).Data;
>>         LabelsTest = SamplesData(teIdx(j)).Labels;
>>         tic
>>         Predictor = predict(classificationLDA,DataTest);
>>         testing_time(teIdx(j))=toc;           %in seconds
>>         Predictor(strcmp('Discard',LabelsTest)) = [];
>>         LabelsTest(strcmp('Discard',LabelsTest)) = [];
>>         Accuracy(teIdx(j)) = nnz(strcmp(Predictor,LabelsTest))...
           /size(LabelsTest,1);
>>         ConfusionMat = ConfusionMat + confusionmat( ...
           LabelsTest,Predictor,'order',CellTypes);
>>     end
>>     clear j
>> end
>> Total_time = sum(training_time)+sum(testing_time);
>> training_time = mean(training_time);
>> testing_time = mean(testing_time);
>> cvAcc = mean(Accuracy)*100;
>> cvSTD = std(Accuracy)*100;
>> disp(['LDA Accuracy = ' num2str(cvAcc) ' ' char(177) ' ' ...
   num2str(cvSTD) ' %'])

LDA Accuracy = 99.0292 ± 2.2556 %

>> clear i Predictor classificationLDA trIdx teIdx CVO DataTrain
   LabelsTrain
>> clear DataTest LabelsTest


%% Performance evaluation

% F1 measure
>> Precision = diag(ConfusionMat)./sum(ConfusionMat,1)';
>> Recall = diag(ConfusionMat)./sum(ConfusionMat,2);
>> Fmeasure = 2 * (Precision.*Recall)./(Precision+Recall);
>> MedianFmeasure = median(Fmeasure);
>> Subset_size = sum(ConfusionMat,2);
>> WeightedFmeasure = (Subset_size./sum(Subset_size))'*Fmeasure;

>> disp(['Median F1-score = ' num2str(MedianFmeasure)])

Median F1-score = 0.98646
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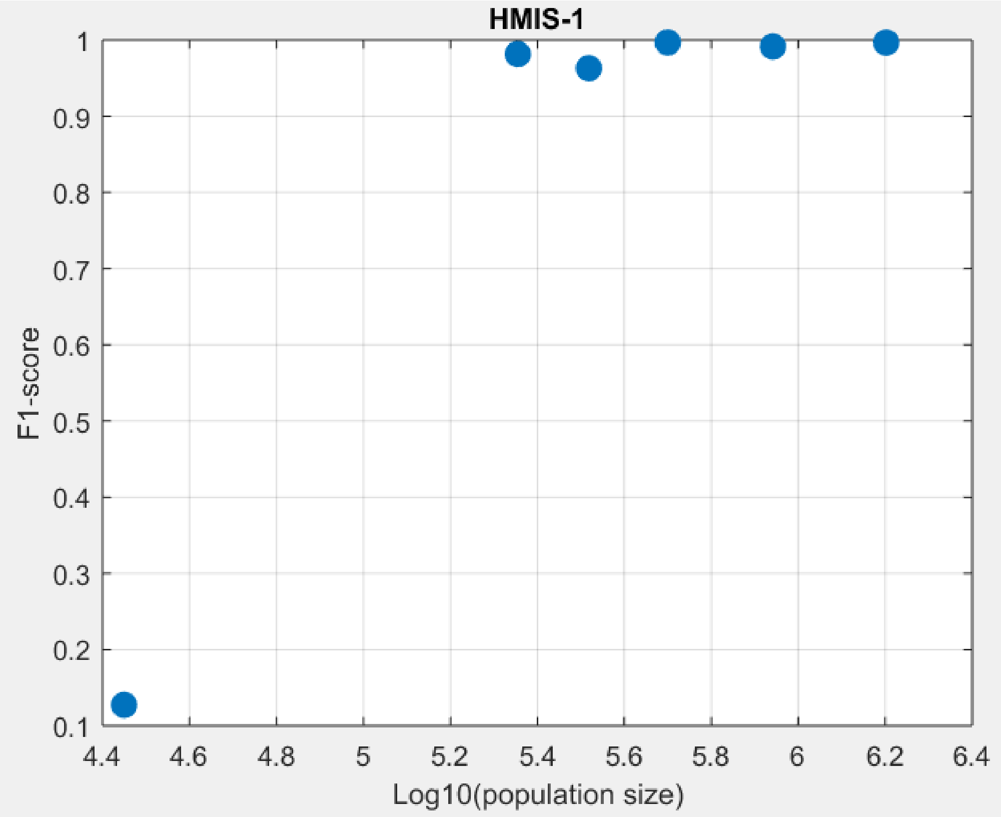
```
>> figure,scatter(log10(Subset_size),Fmeasure,100,'filled')
>> title('HMIS-1')
>> xlabel('Log10(population size)'),ylabel('F1-score')
>> box on, grid on
```



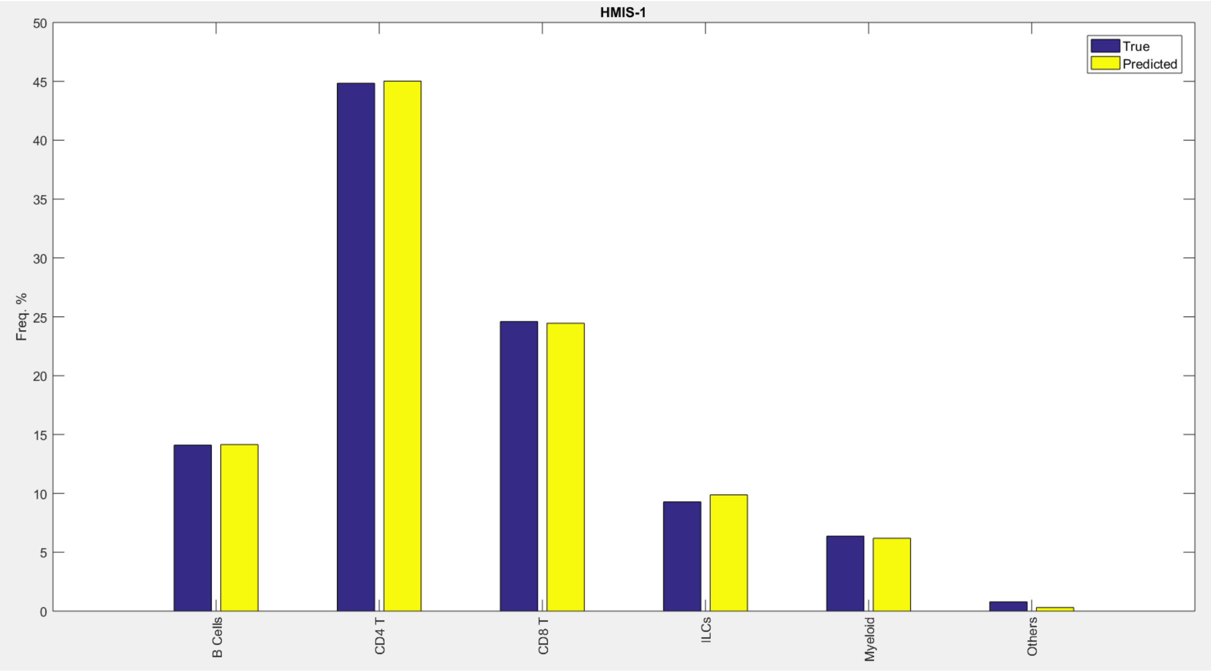
```
%% Population Frequency

>> True_Freq = sum(ConfusionMat,2)./sum(sum(ConfusionMat));
>> Predicted_Freq = sum(ConfusionMat,1)'./sum(sum(ConfusionMat));
>> Max_Freq_diff = max(abs(True_Freq-Predicted_Freq))*100;

>> disp(['delta_f = ' num2str(Max_Freq_diff)])

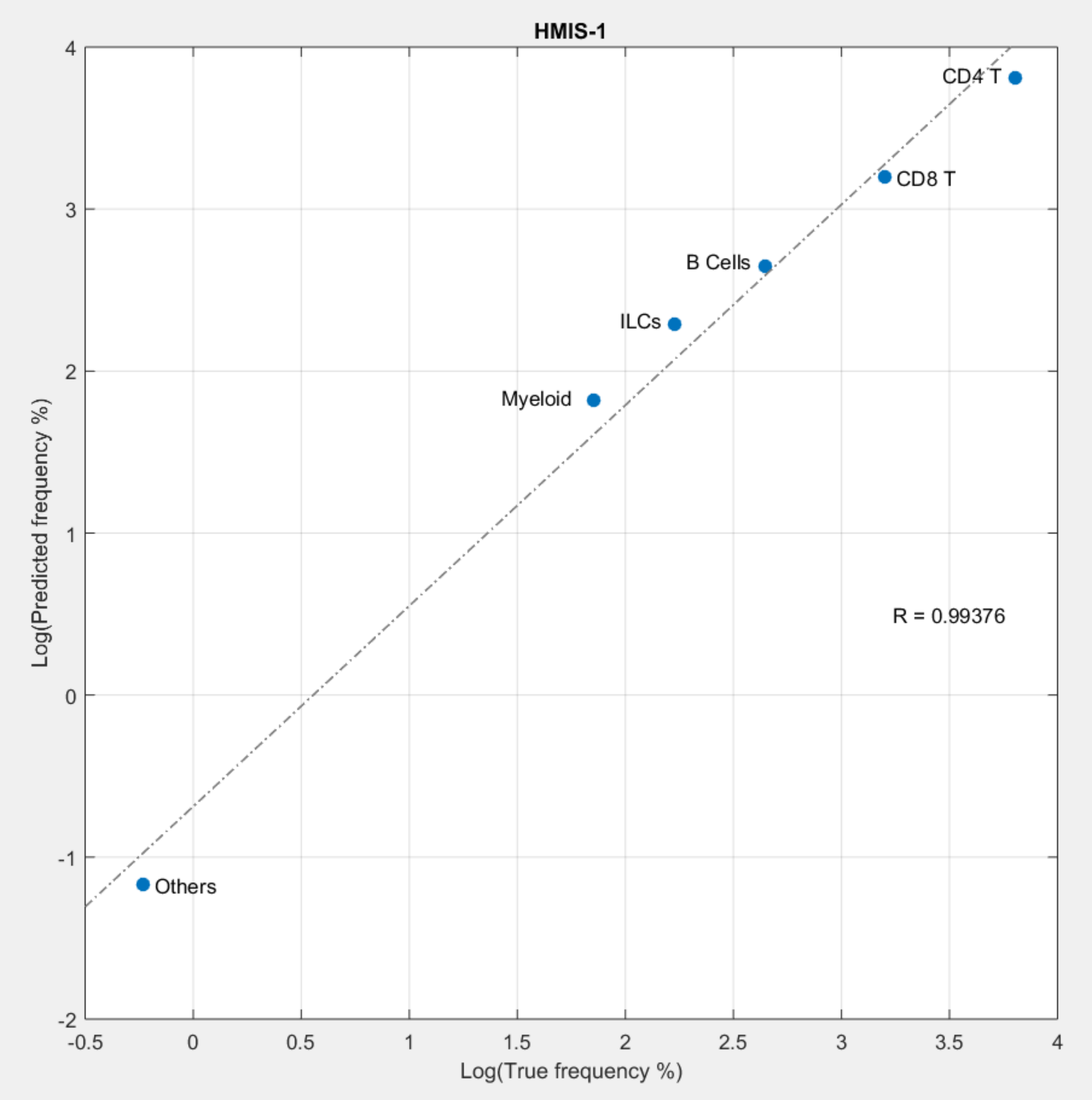
delta_f = 0.59467

>> figure,bar([True_Freq*100 Predicted_Freq*100])
>> xticks(1:6)
>> xticklabels(CellTypes)
>> xtickangle(90)
>> set(gca,'FontSize',10)
>> set(gca,'XLim',[0 7])
>> legend({'True','Predicted'},'FontSize',10)
>> legend show
>> ylabel('Freq. %'),title('HMIS-1')
```



```
%% Population Frequency scatter plot

>> X=log(True_Freq*100);
>> Y=log(Predicted_Freq*100);
>> figure,scatter(X,Y,50,'filled')
>> box on, grid on
>> xlabel('Log(True frequency %)')
>> ylabel('Log(Predicted frequency %)')
>> title('HMIS-1')
>> for k=1:length(CellTypes)
>>     text(X(k),Y(k),CellTypes{k})
>> end
>> lsline
>> text(0,0,['R = ' num2str(corr(X,Y))])
```


HMIS-1
CD4 T
CD8 T
B Cells
ILCs
Myeloid
Others
R = 0.99376
Log(Predicted frequency %)
Log(True frequency %)
4
3
2
1
0
-1
-2
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4