```
% Exercise 2
% (a.) Exponential distribution
lambda = 1;
N = [3 9 27 81];
for i=1:4;
    samples = exprnd(lambda,N(1,i),1000);
    % samples is an N by 1000 matrix of exponential random variables
    % i.e. each column is sample of N exponential random variables
    % f is the frequency, x denotes the bin centers
    [f,x] = hist(mean(samples),50);
    % mean(samples) takes the mean along each column and returns a row
    % vector with these values
    subplot(2,2,i), bar(x,f/trapz(x,f)),...
        colormap(bone),...
        title(['Sample Mean PDF: N = ',num2str(N(1,i))]);
    hold on;
    t = min(x):0.01:max(x);
    sigma_squared = 1./N(1,i);
    mu = 1;
    pdf = (1./sqrt(2*pi*sigma_squared))...
        .*exp((-(t-mu).^2)./(2*sigma_squared));
    hold on, subplot(2,2,i),plot(t,pdf,'LineWidth',2);
    axis tight;
end

% clear the plots for the next part of the exercise
clear;

% (b.)  compute 95% confidence interval for the sample mean
 empirically for
% different sample sizes
lambda = 1;
N = [10 50 100 250];
for i = 1:4;
    % generate a matrix of exponential rv's with N rows and 1000
 columns
    % "exprnd(lambda,N(1,i),1000)", then take the mean of each column,
    % each column is a sample of N exponential rv's. This avoids slow
 for
    % loops - MATLAB is optimised for matrix and vector operations.
    sample_mean_df = mean(exprnd(lambda,N(1,i),1000));
    % use quantile to compute empirical confidence intervals.
    % z = quantile(x,alpha) gives me a number z such that alpha
 percent
    % of the entries in a vector x are less than or equal to z.
    % TRY: x = 1:100, quantile(x,0.5), quantile(x,0.01),
 quantile(x,0.95)
    upper_est = quantile(sample_mean_df,0.975);
    lower_est = quantile(sample_mean_df,0.025);
    % The true confidence interval (with lambda = 1) is given by
    % [ 1 - 1.96/sqrt(N), 1+ 1.96/sqrt(N) ] - why?
    % compare the true and estimated confidence intervals
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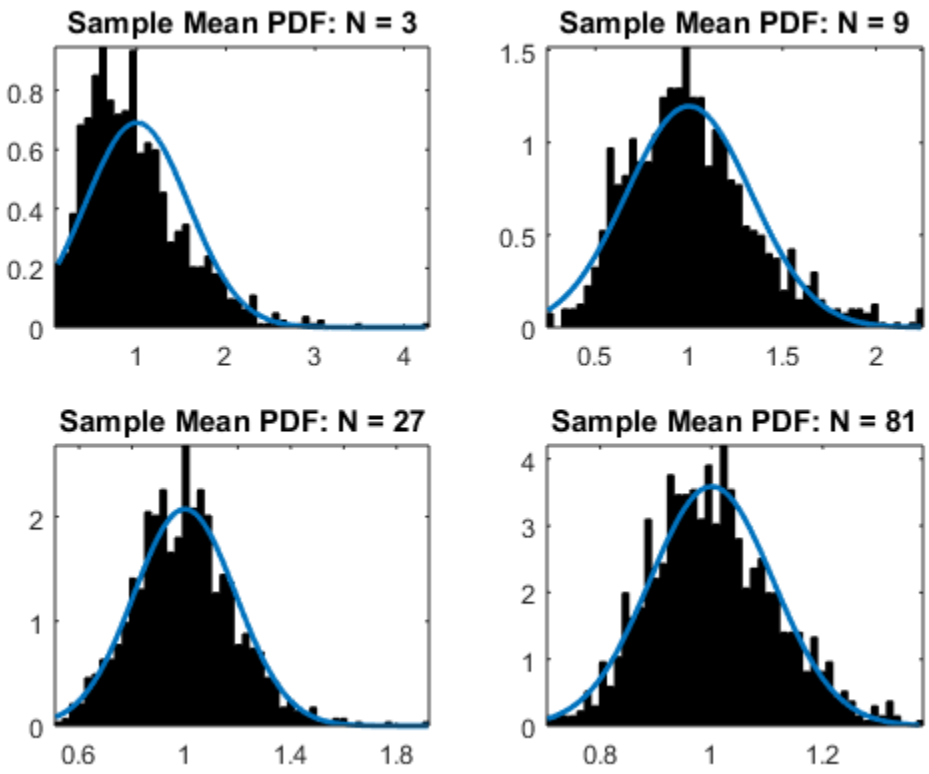
```
    text = ['Estimated confidence interval for N = ',
 num2str(N(1,i)),...
        ' is (',num2str(lower_est),', ',num2str(upper_est),')'];
    text2 = ['The true confidence interval for N = ',
 num2str(N(1,i)),...
        ' is (',num2str(1 - 1.96/sqrt(N(1,i))),', ',...
        num2str(num2str(1 + 1.96/sqrt(N(1,i)))),')'];
    disp(text);
    disp(text2);
    % insert a line break for readability
    fprintf('\n');
end
```

```
Estimated confidence interval for N = 10 is (0.49436, 1.7534)
The true confidence interval for N = 10 is (0.38019, 1.6198)

Estimated confidence interval for N = 50 is (0.73807, 1.2946)
The true confidence interval for N = 50 is (0.72281, 1.2772)

Estimated confidence interval for N = 100 is (0.81117, 1.1882)
The true confidence interval for N = 100 is (0.804, 1.196)

Estimated confidence interval for N = 250 is (0.87265, 1.1265)
The true confidence interval for N = 250 is (0.87604, 1.124)
```



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