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%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% CODE CHALLENGE 2 - Monte Carlo Analysis
%
% The purpose of this challenge is to perform a Monte-Carlo analysis
 on the
% lift generated by an aircraft.  The aircraft has the following
 characteristics:
%   Wing surface area, S = 80 m^2
%   Lift coefficient, C_L = 0.90 +- 0.03
%
% And is flying under the following conditions
%   Air density, rho = 0.653 kg/m^3
%   Airspeed, V = 100 +- 10 m/s
%
%
 ------------------------------------------------------------------------
%
% To complete the challenge, execute the following steps:
% 1) Sample S, C_L, rho, and V 10,000 times.
% 2) Calculate lift in kilonewtons for each of the 10,000 samplings/
simulations.
% 3) Calculate the best estimate and error for lift and report it to
 the
% command window using appropriate significant figures.
% 4) Plot a histogram of L.
% Bonus 1) Calculate drag in kilonewtons for each of the 10,000
% samplings/simulations.
% Bonus 2) Make a scatterplot of Lift vs Drag.
%
% NOTE: DO NOT change any variable names already present in the code.
%
% Upload your team's script to Canvas to complete the challenge.
%
% NAME YOUR FILE AS Challenge2_Sec{section number}_Group{group
 breakout #}.m
% ***Section numbers are 1 or 2***
% EX File Name: Challenge2_Sec1_Group15.m
%
%
```

```
% 1) Tristan Workman
% 2) Alicia Wu
% 3) Brandi Scarboro
% 4) Jade Babcock-Chi
% 5) Bradley Bishop
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%
```

Housekeeping

(Please don't "clear all" or "clearvars", it makes grading difficult)

```
close all   % Close all open figure windows
clc         % Clear the command window
```

1) Sample S, C_L, rho, and V 10,000 times

(i.e. the S variable should contain 10000 samples of the wing surface area)

```
N = 1e04;
% list all the values and their uncertainties
C_Lorig = 0.9;
C_Luncer = 0.03;
rhoOrig = 0.653;
Vorig = 100;
Vuncer = 10;
% samples!
S = 80 * ones(N,1);
C_L = C_Luncer * randn(N,1) + C_Lorig;
rho = 0.653 * ones(N,1);
V = Vuncer * randn(N,1) + Vorig;
```

2) Calculate lift in kilonewtons for each of the 10,000 samplings/simulations.

Given that the equation for lift is: L = 0.5 * rho * V^2 * C_L * S (Newtons)

```
% lift equation!
L = (0.5 .* rho .* V.^2 .* C_L .* S) ./ 1000;
```

3) Calculate the best estimate and error for lift

Report it to the command window using appropriate significant figures.

```
% find the error! :^)
L_best = mean(L)
L_err = (mean(sqrt(((0.5 .* rho .* 2 .* V .* C_L .* S) .* Vuncer).^2 +
 ((0.5 .* rho .* V.^2 .* S) * C_Luncer).^2)) ./ 1000)
% test to see if its reasonable!!!
a = L_best + L_err;
b = L_best - L_err;
```

```
L_best =

  238.1154

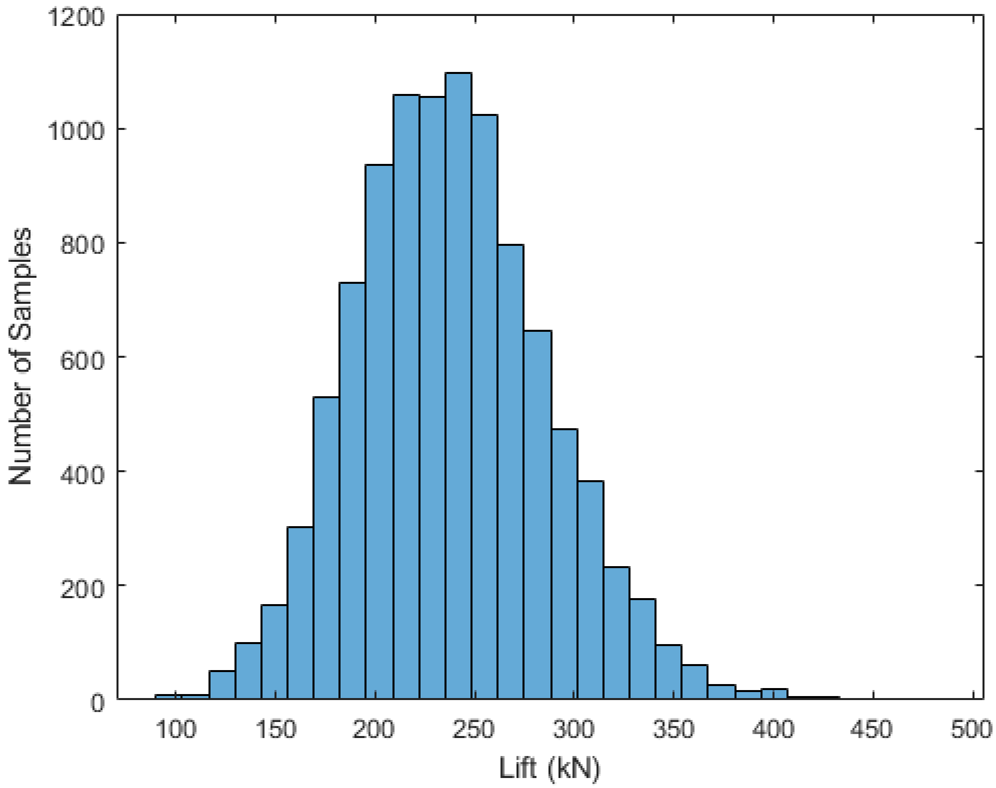

L_err =

   47.7570
```

4) Plot a histogram (use the "histogram" command) of L with 30 bins.

Add annotations and labels for style points!

```
% nice histogram!
histogram(L,30)
xlabel("Lift (kN)")
ylabel("Number of Samples")
```



Bonus 1) Calculate drag in kilonewtons

For each of the 10,000 samplings/simulations, given that the equation for drag is: D = 0.5 * rho * V^2 * C_D * S (Newtons) and that C_D = 0.070 +- 0.005

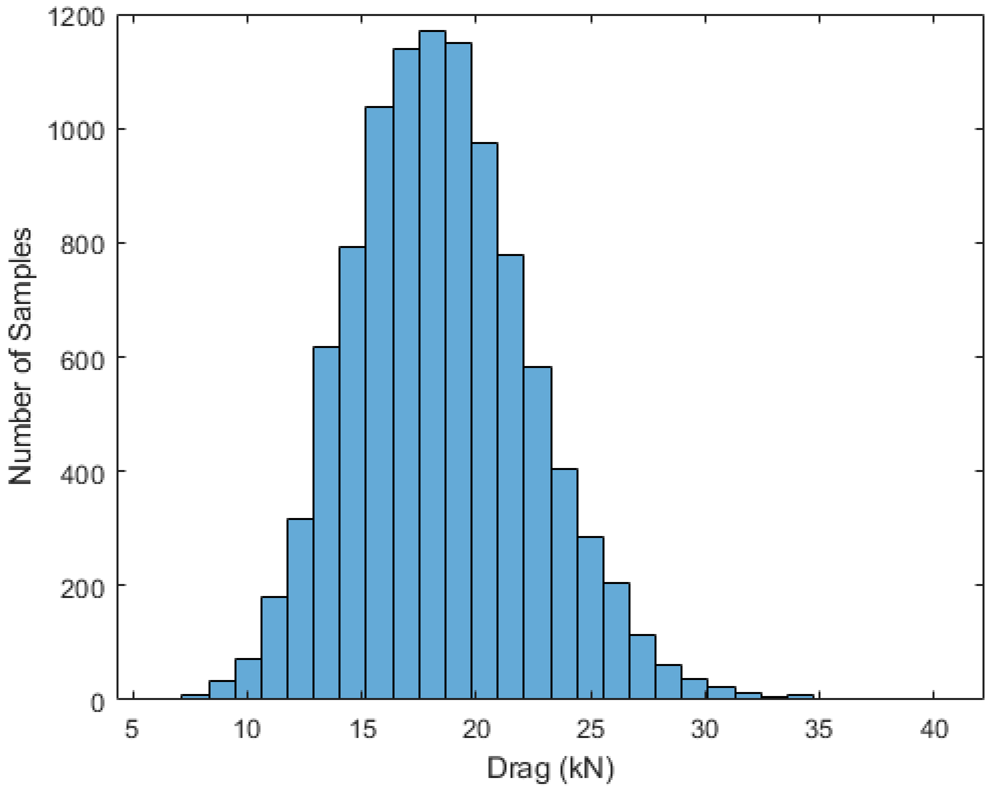
```
% establish best estimate and uncertainty variables
C_Dorig = 0.07;
C_Duncer = 0.005;
% create 10000 samples using established numbers
C_D = C_Duncer * randn(N,1) + C_Dorig;
% calculate drag using values from C_D
D_all = (0.5 .* rho .* V.^2 .* C_D .* S) ./ 1000;
D = mean((0.5 .* rho .* V.^2 .* C_D .* S) ./ 1000)
% using the general method, propogate error through the drag equation
 to
% determine uncertainty
D_err = (mean(sqrt(((0.5 .* rho .* 2 .* V .* C_D .* S) .* Vuncer).^2 +
 ((0.5 .* rho .* V.^2 .* S) .* C_Duncer).^2)) ./ 1000)
% graph values of drag to confirm normal distribution
histogram(D_all,30)
xlabel("Drag (kN)")
ylabel("Number of Samples")
```

```
D =

   18.5150


D_err =

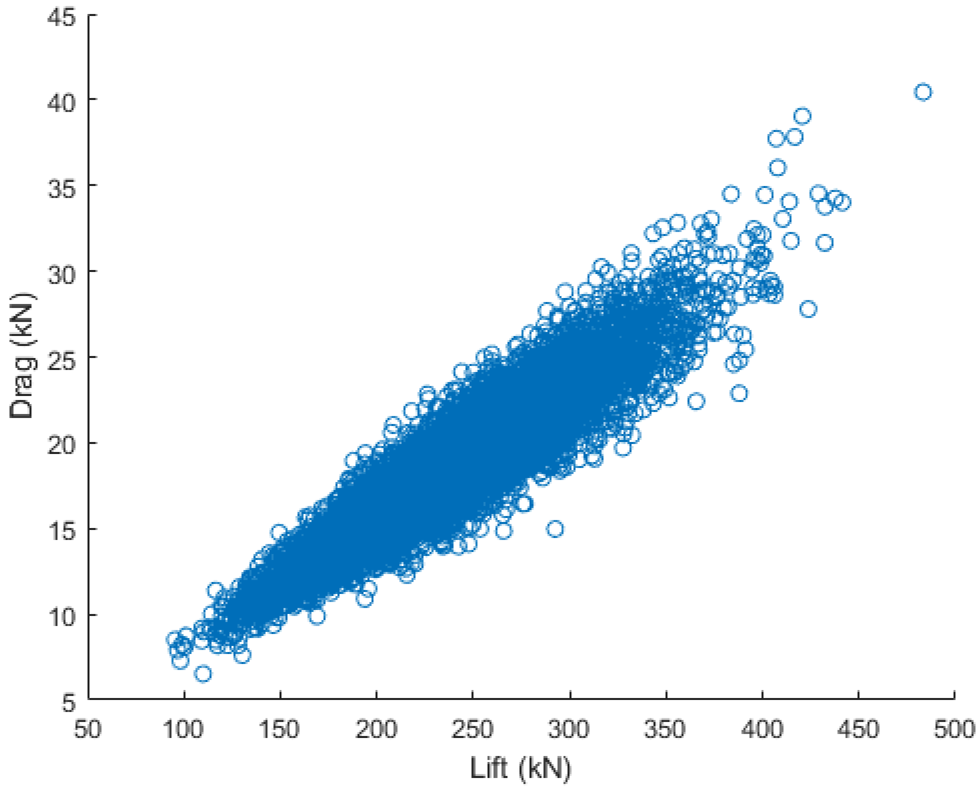
    3.8960
```



Bonus 2) Make a scatterplot of Lift vs Drag.

Think about the following (no work to do): - Why do you think the points are spread into an ellipse and not a circle? - What is the significance of the general trend/slope of the data? - How could this sort of analysis be useful when dealing with more complicated systems and equations?

```
scatter(L,D_all)
xlabel("Lift (kN)")
ylabel("Drag (kN)")
% it appears there is a general trend of proportionality between drag
 and
% lift, where an increase in one stipulates an increase in the other.
```



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