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```
%%%%%%%%%%%%%%%%%%%%%%%%%%%
%CODE CHALLENGE 1 -
%
% The purpose of this challenge is to estimate atmospheric pressure in
% Boulder CO using a pressure model and measurements, and compare the
 two
% through error analysis and statistics.
%
% To complete the challenge, execute the following steps:
% 1) Load the given dataset
% 2) Extract altitude and pressure data
% 3) Determine standard deviation, variance, mean, and
%    standard error of the mean of the pressure data
% 4) Using information given about the instrument, find uncertainty
 associated
%    with altitude measurements
% 5) Use the model to predict pressure measurements at each altitude
 in the
%    data set, along with propagated uncertainty
% 6) Compare results, discuss, and print answers to the command
 window.
% Bonus) Repeat for larger measurement uncertainty in altitude
%
% 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 Challenge1_Sec{section number}_Group {group
 breakout #}.m
% ***Section numbers are 1 or 2***
% EX File Name: Challenge1_Sec1 _Group15.m
%
%
% 1)
% 2)
% 3)
```

```
% 4)
% 5)
%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%

% Housekeeping
clear all   % Clear all variables in workspace
close all   % Close all open figure windows
clc           % Clear the command window
```

1) Load data from given file

```
Data = readtable('PressureInBoulder.csv');
```

Warning: The DATETIME data was created using format 'MM/dd/uuuu HH:mm' but also matched 'dd/MM/uuuu HH:mm'.
To avoid ambiguity, use a format character vector. e.g. '%{MM/dd/uuuu HH:mm}D'
Warning: Table variable names were modified to make them valid MATLAB identifiers. The original names are saved in the VariableDescriptions property.

2) Extract just the altitude and station pressure data columns to meaningfully named variables

```
AltitudeData = table2array(Data(:,3));
h = AltitudeData;
PressureData = table2array(Data(:,2));
%
```

3) Determine Statistics and Error

% the standard deviation, variance, mean, and standard error of the mean (sem) of the pressure data

```
N = length(PressureData);

MeanPressure = sum(PressureData) / N;

BLAH = sum(PressureData-MeanPressure);
%
StdevPressure = sqrt((1/(N))*(BLAH^2));
%
VarPressure = (1/(N))*(BLAH^2);
%

%
Sem_Pressure= StdevPressure/sqrt(N);
%
```

4) Uncertainty

% The altitude measurements were taken using an instrument that displayed % altitude to the nearest tenth of a meter.

% What is the associated absolute uncertainty with these measurements?

```
AltitudeUncertainty = 0.05;   % [m]
%
```

5) Pressure Predictions

% Using the altitude measurements and uncertainty, predict pressure with the follwing model: % First, propagate uncertainty BY HAND before calculating uncertainty for each value. % Then check: is it different for each calculation?

% Model % P_est = P_s * e^(-k*h) % Assume P_s is 101.7 ± 0.4 kPa and k is 1.2*10^(-4) [1/m]

```
 P_s = 101.7;       % ± 0.4 [kPa]
 k = 1.2*10^(-4);   % [1/m]
%
 P_est = P_s*exp(-k*AltitudeData);
% GENERAL RULE QUADRITURE
 P_sig = sqrt((exp(-k.*h)*(.4)).^2+(P_s.*(-h).*exp(-
k.*h)*(5*10^(-6))).^2+(P_s*(-k)*exp(-k.*h)*(AltitudeUncertainty)).^2);

 %
```

6) Print Results

% Display the predicted pressure from the model with it's associated uncertainty and % the average pressure with the it's standard error of the mean from the data.

```
 results  = table(P_est,P_sig);
 P_data = [num2str(MeanPressure) '  ± ' num2str(Sem_Pressure) '
 kPa'];
 disp(results);
 disp(P_data);
%
% % Disucss the accuracy of the model and whether or not you think the
% % model agrees with the measurements
%
 fprintf('\nModel Discussion: If we look at the printed vector
 variable "results", \nwe see that the estimated pressure with
 the added uncertainty comes well within \nour mean pressure and
 uncertainty. So we collective agree that the estimate \nwe made based
 on the model agree with the averages.\n ')
%
```

P_est	P_sig
83.765	0.75305

```
    83.767    0.75299
    83.766      0.753
    83.766    0.75302
    83.767    0.75299
    83.767    0.75299
    83.765    0.75305
    83.767    0.75299
    83.767    0.75299
    83.766      0.753
    83.764    0.75308
    83.767    0.75299
    83.765    0.75303
    83.767    0.75299
    83.767    0.75299
    83.766    0.75302
    83.767    0.75299
    83.767    0.75299
    83.767    0.75298
    83.767    0.75299
    83.767    0.75299
    83.766      0.753
    83.764    0.75306
    83.765    0.75305
    83.765    0.75305
    83.767    0.75299

84.3025  ± 2.2409e-14   kPa

Model Discussion: If we look at the printed vector variable
 "results",
we see that the estimated pressure with the added uncertainty comes
 well within
our mean pressure and uncertainty. So we collective agree that the
 estimate
we made based on the model agree with the averages.
```

Bonus

% Repeat steps 4-6, but assume the altitude measurements were taken on a % lower precision instrument that only displayed altitude to nearest 10 % meters % How does this change the results and comparison ?

altitude_uncertainty_new = 5 % [m]

4) Uncertainty

% The altitude measurements were taken using an instrument that displayed % altitude to the nearest tenth of a meter.

% What is the associated absolute uncertainty with these measurements?

```
NewAltitudeData = round(AltitudeData,-1);
AltitudeUncertainty = 5;   % [m]
```

```
%
```

5) Pressure Predictions

% Using the altitude measurements and uncertainty, predict pressure with the follwing model: % First, propagate uncertainty BY HAND before calculating uncertainty for each value. % Then check: is it different for each calculation?

% Model % P_est = P_s * e^(-k*h) % Assume P_s is 101.7 ± 0.4 kPa and k is 1.2*10^(-4) [1/m]

```
P_s = 101.7;       % ± 0.4 [kPa]
k = 1.2*10^(-4);   % [1/m]
%
P_est = P_s*exp(-k*NewAltitudeData);
% GENERAL RULE QUADRITURE
P_sig = sqrt((exp(-k.*h)*(.4)).^2+(P_s.*(-h).*exp(-
k.*h)*(5*10^(-6))).^2+(P_s*(-k)*exp(-k.*h)*AltitudeUncertainty).^2);

%
```

6) Print Results

% Display the predicted pressure from the model with it's associated uncertainty and % the average pressure with the it's standard error of the mean from the data.

```
results  = table(P_est,P_sig);
P_data = [num2str(MeanPressure) '  ± '
num2str(Sem_Pressure) '   kPa'];
disp(results);
disp(P_data);
%
% % Disucss the accuracy of the model and whether or not you
think the
% % model agrees with the measurements
%
fprintf('\nModel Discussion BONUS: When we assumed that the
altitude measurements were taken on a lower precision instrument that
only displayed altitude\n to the nearest 10 meters, our model was
still relatively accurate. However, as compared to a more accurate
measuring device,\n the results are farther off of the mean for the
less accurate device. When thinking intuitively, this would make
sense as a more accurate\n device has a smaller standard deviation
and a smaller error.')
%
```

P_est	*P_sig*
83.733	*0.75472*
83.733	*0.75467*
83.733	*0.75468*
83.733	*0.75469*
83.733	*0.75467*

```
    83.733    0.75467
    83.733    0.75472
    83.733    0.75467
    83.733    0.75467
    83.733    0.75468
    83.733    0.75475
    83.733    0.75467
    83.733    0.75471
    83.733    0.75467
    83.733    0.75467
    83.733    0.75469
    83.733    0.75467
    83.733    0.75467
    83.733    0.75465
    83.733    0.75467
    83.733    0.75467
    83.733    0.75468
    83.733    0.75474
    83.733    0.75472
    83.733    0.75472
    83.733    0.75467

84.3025  ± 2.2409e-14   kPa

Model Discussion BONUS: When we assumed that the altitude measurements
 were taken on a lower precision instrument that only displayed
 altitude
 to the nearest 10 meters, our model was still relatively accurate.
 However, as compared to a more accurate measuring device,
 the results are farther off of the mean for the less accurate device.
 When thinking intuitively, this would make sense as a more accurate
 device has a smaller standard deviation and a smaller error.
```

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