BMED 3310 Dimensional Analysis Project

Fall 2025

Contents

Getting Started

Overview of the MATLAB graphical user interface (GUI):

- **Command Window**: This is where you enter commands one at a time. Test out short snippets of code here. You can also view the output of your scripts here.
- **Editor**: This is the primary window for writing and editing your MATLAB scripts (.m files) and functions. Clicking on the “Run” button will execute this script.
- **Workspace**: This pane displays all the variables currently loaded in your MATLAB session. You can see their names, values, and data types. Double-clicking a variable opens a Variable Editor to inspect it in a spreadsheet-like view.
- **Current Folder**: This window shows the contents of your current working directory. MATLAB only has access to files in this folder or on its search path. Recommendation: create a single dedicated folder for this project.

Writing Readable Code:

Writing clear, readable code is a practice that will save you time and headaches in the long run. It will also allow others (e.g., the graders or future co-workers) to more easily interpret your work.

- **Use comments and section headers**: Use the % symbol to add comments to your code. Comments should explain why you are doing something. This is particularly important for complex sections of code. Similarly, you can create section headers by using by using %%.
- **Use meaningful variable names**: Give your variables descriptive names like pi_exponents or basis_parameters instead of x or y. This makes your code self-documenting.
- **Use proper indentation**: Indent your code within loops (for, while) and conditional statements (if, else).

Tips for Debugging Code:

Inevitably, you will need to debug your code. Here are a few tips to help you find and fix errors efficiently.

- **Read the error messages**: MATLAB's error messages can be helpful. They tell you the type of error and the specific line number where it occurred.
- **Use the debugger**: Set breakpoints by clicking on the gray area to the left of the line number. When you run your code, it will pause at the breakpoint, allowing you to inspect the values of variables in the Workspace.
- **Output to the Command Window**: Insert disp() or fprintf() statements to display the values of variables at different points in your code. You can also simply unsuppress an output by removing the semi-colon.
- **Use help and doc commands:** If you are struggling to utilize a MATLAB function, you can type help or doc followed by the function name in the command window. For example: `help fitlm`. This will bring up documentation to assist you.

Before the project workday in PSS:

- Download and install MATLAB 2024a or newer (with the Statistics and Machine Learning Toolbox).
- Create a project folder and download the `ProjectDataGenerator.p` MATLAB function from Canvas.
  - Each student will be given a unique numerical key on Canvas. Attempt to access your dataset as follows: `projectdata = ProjectDataGenerator(key);`
- Review lectures materials from 9/30 and 10/9 which cover dimensional analysis and the project background context.
- Preview the instructions for parts 1 – 4 of this project. This will allow you to maximize your time during the workday.

General project guidelines / grading:

- **Collaborate don't copy:** Students are encouraged to collaborate, but the work you submit must be your own. As a rule of thumb, you can discuss your work with others but do not send/share code or work to others. If substantially similar work is submitted, this is considered academic misconduct for both the sender and recipient.
- **MATLAB is the required software for this project.** While you may use other programs to verify your work, all submitted assignments must be completed in MATLAB to ensure consistent evaluation.
- **Each project part will be graded using the framework below.** Note: lower levels must be achieved to receive credit for the higher levels.

Project Grading System		
Level 3 (5% | 15%)	The submitted deliverable displays a high level of readability. See *Writing Readable Code.*	Requested outputs are accurate.
Level 2 (20%)	The submitted script runs without errors, and all requested deliverables / outputs are present in the requested format.	
Level 1 (60%)	Project part is submitted correctly and on time. The student makes an honest effort to complete all parts of the project, but the script may not fully run.	

Background Context

You are working at a biomedical engineering company or research lab developing a novel microfluidic device. Microfluidics is the science of manipulating fluids in micro-scale channels. In a biomedical context, these systems are highly versatile, forming the basis of technologies like single-cell sequencing (e.g., Drop-seq), lateral flow assays (e.g., COVID test), and organs-on-chips – which are designed to mimic the structure and function of human organs on a smaller scale. Side note: In BMED 4775 Translational Microsystems, you can get hands-on experience building some of these devices like a microfluidic mixer.

Since each student receives a different randomized dataset, we cannot specify an exact context, but the process is generally applicable. Your team has gathered a large set of experimental data from 200 tests. A brief overview of the parts of the project is below.

Part 1: Finding Pi Groups
To simplify the analysis of your complex experimental data, you must first employ the Buckingham Pi Theorem. In this phase, you will use dimensional analysis on your raw data to reduce the number of initial physical variables (e.g., length, velocity, and density) into a smaller, more manageable set of dimensionless groups (π groups). This process is essential for creating a generalized model that is independent of the unit system.

Part 2: Data Fitting
After deriving your dimensionless groups, you will focus on the empirical relationship between them. You will use regression modeling (i.e., multi-linear, exponential, and power fits) on your π groups to create a mathematical correlation equation . This equation will allow you to quickly input any set of initial π group parameters and accurately predict the device's function (e.g., mixing efficiency) without needing to run another physical test. Side note: Later in the semester, we will encounter equations which were developed using a similar process.

Part 3: Unscaling Coefficients, Choosing the Best Fit, and Identifying Critical Pi Groups
You will then analyze the three mathematical models developed in Part 2. You must select the single best model using statistical criteria and then identify which of the independent π groups are statistically critical to the device's function.

Part 4: Scale Modeling
Using microfluidics in initial device testing can be immensely beneficial from a cost and convenience standpoint. The small material/reagent amounts drastically reduce testing costs. However, in certain scenarios, the final product that you want to develop is on a much different size scale. In this part, you will conceptualize the full-scale prototype. This involves calculating the new, appropriate material properties (e.g., required viscosity or velocity) to ensure the full-scale system replicates the exact performance and function of your small-scale model.

Part 1: Finding Pi Groups

Data skills learning objectives:

1. Students will be able to effectively utilize MATLAB to manipulate large datasets – including performing mathematical calculations.
2. Students will be able to apply Buckingham-Pi Theorem to reduce the number of independent variables in a dataset to enable simpler curve fitting.
3. Students will be able to write readable and well-documented MATLAB code that effectively communicates the process and purpose of a program to others.

Due date and deliverable:

- Due Sunday, October 12th at 11:59 PM to Gradescope
- Deliverable: A single pdf version of your published MATLAB script containing all requested outputs (highlighted in the directions below).

Overview of steps:

1. Load your unique project data set using your assigned key and the project data generator provided on Canvas. Familiarize yourself with the contents of the dataset.
    - Your data set will include: (1) *Measured Parameter Units*, (2) *Measurements,* (3) *Basis Parameter*, and (4) *Dependent Parameter.* Only items 1-3 are relevant for project part 1.
2. Construct a *Unit Exponent Matrix* using the structure below. **<u>The first 3 or 4 columns of this matrix should be your basis parameters in the order provided</u>**. You may construct this matrix manually or automate its construction.
    - Note: If you have three basis parameters, then one dimension is not covered by the bases and must be eliminated. Parameters dependent on that extra dimensions should be removed from your matrix. Therefore, your *Unit Exponent Matrix* will have 3 rows and (10 - # of removed parameters) columns.

	Basis parameter 1 (Ex: Area)	…	Basis parameter 4	Non-basis parameter 1	…	Non-basis parameter 6
Mass Exponent	0	…	*exponent*	*exponent*	…	*exponent*
Length Exponent	2	…	*exponent*	*exponent*	…	*exponent*
Time Exponent	0	…	*exponent*	*exponent*	…	*exponent*
Temperature Exponent	0	…	*exponent*	*exponent*	…	*exponent*

3. Use the rref() function to perform a Gauss-Jordan elimination on your *Unit Exponent Matrix*. The result will be your *Pi Exponent Table* (output this to the Command Window).

    - Forming pi groups by hand by solving the system of equations can be tedious and time-consuming. Instead, rref() enables us to solve the system of equations and solve for all pi group formulas in a single line of code.

    - To help you interpret the *Pi Exponent Table* and generate appropriate pi group formulas, see the general *Pi Exponent Table* below. You should form a pi group for each non-basis parameter.

Basis parameter 1 (b_1)	Basis parameter 2 (b_2)	Basis parameter 3 (b_3)	Non-basis parameter 1 (p_1)	…
1	0	0	a	…
0	1	0	b	…
0	0	1	c	…

Example Formula:

$$\pi_1 = \frac{b_1^a \cdot b_2^b \cdot b_3^c}{p_1}$$

    - **Recommendation (optional):** Check if your pi groups are dimensionless by hand.

4. Utilize the *Pi Exponent Table* to transform your *Measurements* into a *Table of Pi Group Values*.

    - The *Measurements* table has 200 rows and 10 columns: 200 observations/experiments and 10 dimensioned parameters.

    - The *Table of Pi Group Values* will have 200 rows and X columns – where X is number of pi groups.

    - Hint: You may need to refresh on element-wise math operations in MATLAB.

5. Output the *Table of Pi Group Values* to the Command Window.

    - Utilize `format short e` to display your table in scientific notation (see the example at the end of this document).

6. Publish your script and submit it to Canvas as a pdf.

    - On the Publish tab, click Publish. Save as a pdf. Check that all requested items are present. Submit to Gradescope.

    - An example of the pdf you should submit is at the end of this document.

Part 2: Data Fitting

Data skills learning objectives:

1. Students will be able to implement multi-linear and non-linear regression models in MATLAB to fit experimental data.
2. Students will be able to write readable and well-documented MATLAB code that effectively communicates the process and purpose of a program to others.

Due date and deliverable:

- Due Sunday, October 19th at 11:59 PM to Gradescope
- Deliverable: A single pdf version of your published MATLAB script containing all requested outputs (highlighted in the directions below).

Overview of steps:

1. Load in data from Part 1 of this project.
   - **Important note:** The official results for Part 1 will be released after its due date. While you may work ahead, ensure your starting data is correct before submission of Part 2.
2. Scale (i.e., normalize to max) your pi group data. Simply divide each set (200 values) of pi group data by the maximum value in the set.
   a) *Why do we do this?* The fitting algorithms we will use are highly sensitive to the magnitude of the parameters. By scaling all groups to their respective maximum value, we improve the efficiency of the fitting algorithms – allowing for faster and more reliable convergence at a solution.
3. Identify your independent and dependent pi data. Isolate them as separate variables in MATLAB. The pi group containing your *Dependent Parameter* is your dependent variable. All other pi groups will be your independent variables.
4. Perform 4 fits shown below on your data set. Boxes 1 and 2 provide additional information for fitting.
   a) Multi-linear fit using `fitlm()`. Display the multi-linear model to the command window.

```
fitlm(independent pi group data, dependent pi group data, “linear”);
```

   b) Multi-linear fit using `fitnlm()`. Display the multi-linear model to the command window. **Note:** This is an opportunity for you to self-evaluate your results. You should get the same result as step above.

```
fitnlm(independent pi group data, dependent pi group data, multi-
linear model function, initial guess at coefficients);
```

c) Exponential fit using `fitnlm()`. Display the exponential model to the command window.

```
fitnlm(independent pi group data, dependent pi group data, exponential model function, initial guess at coefficients);
```

d) Power fit using `fitnlm()`. Display the power model to the command window.

```
fitnlm(independent pi group data, dependent pi group data, power model function, initial guess at coefficients);
```

7. Publish your script and submit it to Canvas as a pdf.

   - On the Publish tab, click Publish. Save as a pdf. Check that all requested items are present. Submit to Gradescope.
   - An example of the pdf you should submit is at the end of this document.

Box 1 – Model Functions

When fitting using fitnlm(), you must specify the equation that you want to fit to. In this case, we are fitting the multi-linear, exponential, and power functions shown below.

Multi-linear: $y = \beta_0 + \sum_{i=1}^{n}(\beta_i x_i) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n$

Exponential: $y = \beta_0 \exp(\sum_{i=1}^{n}(\beta_i x_i)) = \beta_0 e^{(\beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n)}$

Power: $y = \beta_0 x_1^{\beta_1} x_2^{\beta_2} \ldots x_n^{\beta_n}$

In these functions: y is your dependent or predicted variable (i.e., dependent pi group), x_i are your independent (predictor) variables (i.e., independent pi groups), and β_i are your model coefficients.

We now need to write the model function in a format that MATLAB can interpret. As an example, the **exponential model function** is below.

Exponential Model Function: `@(b,x)b(1)*exp(x*b(2:end))`

`@(b,x)` – defines the input variable b as the coefficient vector and x as the matrix of predictor data

`b(1)` – represents the scaling coefficient (β_0). Reminder that indexing in MATLAB starts at 1.

`exp(x*b(2:end))` – represents $e^{(\beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n)}$. Note: Matrix algebra allows us to write this expression concisely. However, you could write an equivalent function using element-wise mathematics.

Your task: Develop appropriate functions for the multi-linear and power models to use in fitnlm.

Box 2 – Initial Guess at Coefficients

Curve fitting algorithms – like fitnlm – will iteratively adjust the values of the model function coefficients until converging at an optimal set of coefficients. The initial guess that you provide is the starting point. A "good" initial guess can be critical to the speed and success of this process.

Determining a "good" initial guess can be complex. Our recommendation for this project is to utilize log transformations to linearize the exponential and power model functions.

Initial Guess for Exponential Model:

- Use the coefficients obtained from a linear fit of the independent data and the log(dependent data).
- fitlm(independent data, log(dependent data), "linear")
- You will need to update the scaling coefficient (i.e., b(1)) to be the exponential of the estimate — exp(b(1)).

Initial Guess for Power Model:

- Use the coefficients obtained from a linear fit of the log(independent data) and the log(dependent data).
- fitlm(log(independent data), log(dependent data), "linear")
- You will need to update the scaling coefficient (i.e., b(1)) to be the exponential of the estimate — exp(b(1)).

Why this works…

Linearization of an Exponential Function: $y = \beta_0 e^{(\beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n)}$

$$\log(y) = \log\left(\beta_0 e^{(\beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n)}\right)$$

$$\log(y) = \log(\beta_0) + \log\left(e^{(\beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n)}\right) = \log(\beta_0) + \log\left(e^{\beta_1 x_1} e^{\beta_2 x_2} \ldots e^{\beta_n x_n}\right)$$

$$\log(y) = \log(\beta_0) + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n$$

Notice how the above equation is the multi-linear function with $\log(y)$ as the dependent variable and $\log(\beta_0)$ as the intercept.

Linearization of a Power Function: $y = \beta_0 x_1^{\beta_1} x_2^{\beta_2} \ldots x_n^{\beta_n}$

$$\log(y) = \log\left(\beta_0 x_1^{\beta_1} x_2^{\beta_2} \ldots x_n^{\beta_n}\right)$$

$$\log(y) = \log(\beta_0) + \log\left(x_1^{\beta_1}\right) + \log\left(x_2^{\beta_2}\right) + \cdots + \log\left(x_n^{\beta_n}\right)$$

$$\log(y) = \log(\beta_0) + \beta_1 \log(x_1) + \beta_2 \log(x_2) + \cdots + \beta_n \log(x_n)$$

Notice how the above equation is the multi-linear function with $\log(y)$ as the dependent variable, $\log(x_i)$ as the independent variables, and $\log(\beta_0)$ as the intercept.

Part 3: Unscaling Coefficients, Choosing the Best Fit, and Identifying Critical Pi Groups

Data skills learning objectives:

1. Students will be able to develop and apply the necessary mathematical transformations to unscale regression model coefficients obtained from normalized data.
2. Students will be able to evaluate and select the most appropriate regression model by interpreting key statistical metrics.
3. Students will be able to write readable and well-documented MATLAB code that effectively communicates the process and purpose of a program to others.

Due date and deliverable:

- Due Sunday, October 26th at 11:59 PM to Gradescope
- Deliverable: A single pdf version of your published MATLAB script containing all requested outputs (highlighted in the directions below).

Overview of steps:

1. Load in data from Parts 1 and 2 of this project. You will need the original (non-scaled) pi group values from Part 1, and you will need the multi-linear, exponential, and power regression models from Part 2.
   - **Important note:** The official results for Part 2 will be released after its due date. While you may work ahead, ensure your starting data is correct before submission of Part 2.
2. Use the maximum value for each non-scaled pi group to unscale the regression model coefficients. See Box 3.
   a) Calculate/display the unscaled multi-linear model coefficients to the command window
   b) Calculate/display the unscaled exponential model coefficients to the command window
   c) Calculate/display the unscaled power model coefficients to the command window
3. Utilize AIC (Akaike Information Criterion) values for each model to identify the best fit.
   - You can access these values using the following structure: `fit.ModelCriterion.AIC`
   - Print a statement to the command window specifying (1) the best model and (2) how you used AIC values to make this selection.
4. Using the preferred fit, identify the critical pi groups. It is likely that not all predictor variables (i.e., independent pi groups) are important to the fit.
   - Determine the critical pi groups using p-values.

- Use an initial significance (α) level of 0.01. However, adjust this value using a Bonferroni correction based on the number of independent variables.
- Display the criterion for selecting a critical pi group based on p-value.
- Display the names of the non-basis parameter associated with each critical pi group (see example at the end of this document).
    - **Note:** Remember that the first coefficient is the intercept or scaling factor; it is not associated with a pi group.

5. Publish your script and submit it to Canvas as a pdf.

- On the Publish tab, click Publish. Save as a pdf. Check that all requested items are present. Submit to Gradescope.
- An example of the pdf you should submit is at the end of this document.

Box 3 – Mathematical Transformations to Unscale Model Coefficients

For all three (distinct) fits that we performed, we normalized the data to the maximum values before fitting. Therefore, the coefficients that result from fitting are based on this scaled input data.

To increase interpretability and practical application of the model, it is beneficial to unscale the coefficients. These mathematical transformations are shown below for the multi-linear and exponential models. **You must determine the transformations for the power model.**

Unscaling Multi-Linear Regression Coefficients

$$y_{scaled} = \beta_{0,scaled} + \beta_{1,scaled}x_{1,scaled} + \beta_2 x_{2,scaled} + \cdots + \beta_{n,scaled}x_{n,scaled}$$

If $y_{scaled} = \frac{y}{y_{max}}$ and $x_{i,scaled} = \frac{x_i}{x_{i,max}}$...

$$\frac{y}{y_{max}} = \beta_{0,scaled} + \beta_{1,scaled}\frac{x_1}{x_{1,max}} + \beta_2\frac{x_2}{x_{2,max}} + \cdots + \beta_{n,scaled}\frac{x_n}{x_{n,max}}$$

$$y = y_{max}\beta_{0,scaled} + \frac{y_{max}\beta_{1,scaled}}{x_{1,max}}x_1 + \frac{y_{max}\beta_{2,scaled}}{x_{2,max}}x_2 + \cdots + \frac{y_{max}\beta_{n,scaled}}{x_{n,max}}x_n$$

The expressions for the unscaled coefficients are written in green. In words, all coefficients are multiplied by the raw maximum dependent pi value (y_{max}), and each parameter coefficient is divided by the relevant raw maximum independent pi value ($x_{i,max}$).

Unscaling Exponential Regression Coefficients

$$y_{scaled} = \beta_{0,scaled}e^{(\beta_{1,scaled}x_{1,scaled} + \beta_{2,scaled}x_{2,scaled} + \cdots + \beta_{n,scaled}x_{n,scaled})}$$

$$\frac{y}{y_{max}} = \beta_{0,scaled}e^{\left(\frac{\beta_{1,scaled}}{x_{1,max}}x_1 + \frac{\beta_{2,scaled}}{x_{2,max}}x_2 + \cdots + \frac{\beta_{n,scaled}}{x_{n,max}}x_n\right)}$$

$$y = y_{max}\beta_{0,scaled}e^{\left(\frac{\beta_{1,scaled}}{x_{1,max}}x_1 + \frac{\beta_{2,scaled}}{x_{2,max}}x_2 + \cdots + \frac{\beta_{n,scaled}}{x_{n,max}}x_n\right)}$$

The expressions for the unscaled coefficients are written in orange. In words, the first coefficient ($\beta_{0,scaled}$) is multiplied by the raw maximum dependent pi value (y_{max}), and each parameter coefficient is divided by the relevant raw maximum independent pi value ($x_{i,max}$).

Part 4: Scale Modeling

Learning objective:

1. Students will be able to select appropriate material properties which maintain dynamic similarity between a small-scale model and the full-scale system.

Due date and deliverable:

- Due Sunday, November 2nd at 11:59 PM to Gradescope
- Deliverable: A single 2-3 page pdf write-up containing all requested items (highlighted below). This page count does not include references.
  - This document can be prepared in a word processor (e.g., Microsoft Word), and does not need to be completed in MATLAB.
  - In place of code readability, your write-up will be evaluated on the quality and clarity of written communication.

Description of Task:

Your data was collected from 200 small-scale experiments on your device because the full-scale system was prohibitively expensive or inconvenient to test directly. Observation 1 provided the best performance metrics (e.g., maximum efficiency, optimal mixing, etc.) and represents the target performance you want for the final product.

Task: Use the successful results from your small-scale experiment (Observation 1) to determine the design parameters for the full-scale system that ensures dynamic similitude.

For the prototype to achieve the exact performance predicted by your successful model run, the values of all critical independent pi groups must be identical between the model (Observation 1 data) and the full-scale system (see Box 4).

Requirements / items to include in write up:

1. Provide the values for all critical pi groups from Observation 1
2. Provide the equations for your critical pi groups
3. The full-scale system is geometrically scaled to be 10 times larger than the Observation 1 model.
   - This means that the linear scale factor is 10:
     - Length parameters must be multiplied by 10
     - Area parameters must be multiplied by $10^2 = 100$
     - Volume parameters must be multiplied by $10^3 = 1000$
4. Select appropriate and reasonable values for the non-geometric parameters (e.g., density, viscosity, velocity) for the full-scale system such that the critical independent pi group values are equal to those established in your small-scale model.

5. Provide a table of the dimensioned parameter (e.g., length, velocity, density) values for both Observation 1 and the full-scale system.

	Dimensioned Parameter 1 *(units)*	**Dimensioned Parameter 2** *(units)*	…	**Dimensioned Parameter n** *(units)*
Observation 1				
Full-scale system				

6. Show calculations demonstrating the critical pi group values are identical between Observation 1 and the full-scale system.
7. Justify your value choices for all non-geometric parameters with examples of similar real-world material/system properties (cite resources)
   - Include in-text citations and a list of references. You may choose your preferred style; just be consistent.
   - While you should make every effort to select appropriate and reasonable parameter values. This may not be possible for every parameter. Explain your reasoning if this is the case (e.g., velocity required is greater than the speed of light).
8. Your submitted write-up should not simply be a list of the highlighted items. It should be a report that clearly articulates your process and findings.

Box 4 – Dynamic Similitude

To achieve dynamic similitude, all critical pi group values must be identical between the observation and the full-scale system.

For example, imagine your first observation (obs) has 2 critical pi values:

$$\pi_{1,obs} = \frac{\rho_{obs} v_{obs} L_{obs}}{\mu_{obs}} \qquad \pi_{2,obs} = \frac{\vartheta_{obs}}{\alpha_{obs}}$$

Your full-scale (fs) system needs the same values:

$$\pi_{1,fs} = \frac{\rho_{fs} v_{fs} L_{fs}}{\mu_{fs}} = \frac{\rho_{obs} v_{obs} L_{obs}}{\mu_{obs}} \qquad \pi_{2,fs} = \frac{\vartheta_{fs}}{\alpha_{fs}} = \frac{\vartheta_{obs}}{\alpha_{obs}}$$

Due to the geometric scaling (10x) constraint…

$$L_{fs} = 10 \times L_{obs}$$

All other variables in this example (ρ_{fs}, v_{fs}, μ_{fs}, ϑ_{fs}, α_{fs}) can be freely chosen to make the equations hold true. The only caveat is that the chosen values should be aligned with physical reality.

Appendix: Example Deliverables

Contents

BMED 3310 Computational Project - Part 1

You can create section headers like the one above using %% TEXT. If you place a comment (%) directly below the header, it will display as a sub-header.

```
clear
close all
clc
```

Load in Project Data

```
projectdata = ProjectDataGenerator([redacted]);
```

[redacted]

Create dimensional matrix

You may manually create this matrix or write code to automate its formation

[redacted]

Rearrange dimensional matrix, and use rref to obtain the Pi exponent table

The first three to four columns of your Pi exponent table should be your basis parameters in the order given.

[redacted]

```
[redacted]

% Determine the Reduced Row Echelon Form of the Matrix (Pi exponent table)
rrmatrix = rref([redacted])
```

```
rrmatrix =

  Columns 1 through 6

   1.0000e+00            0            0            0   [redacted]
            0   1.0000e+00            0            0
            0            0   1.0000e+00            0
            0            0            0   1.0000e+00

  Columns 7 through 10

   [redacted]
```

Calculate Pi Groups from Observation Data

```
[redacted]

% Separate dataset into base and non-base matrices
[redacted]

% Create pi group data set
[redacted]

% Set the format to short scientific notation
format short e;

% Display the matrix
disp(pi_data);
```

4.0629e-04	2.3836e-04	1.0974e+01	6.8044e+01	2.0113e-01	9.9102e+09
3.2029e-03	1.8304e-05	6.1909e-01	6.2668e+02	1.0411e-01	1.7246e+08
4.0106e-04	1.4695e-03	2.2158e+01	1.8252e+01	4.0666e+00	9.1790e+10
2.6518e-04	3.4799e-04	8.0384e+00	3.2110e+01	8.8703e-01	2.5385e+10
3.2846e-04	5.7622e-04	5.4818e+00	2.9633e+01	6.7824e-01	5.0353e+10
3.1880e-04	2.2342e-04	1.8025e+01	4.0194e+01	8.2507e-01	2.9127e+10
1.9671e-04	2.9486e-04	6.4536e+00	3.0169e+01	5.5869e-01	4.9759e+09
6.1294e-04	2.1014e-05	1.5147e+00	1.1523e+02	2.7277e-01	1.4512e+09
5.1025e-04	6.9285e-05	4.7131e+00	9.3817e+01	4.0903e-01	2.4796e+09
2.7695e-04	1.1544e-03	1.0428e+01	4.1122e+01	4.6345e-01	1.3213e+10
2.1570e-04	1.1640e-04	1.4139e+01	1.7723e+01	3.6039e-01	3.3297e+10
5.4252e-04	6.5966e-05	1.4871e+00	1.0046e+02	1.0455e+00	2.5839e+09
2.4512e-04	7.2252e-05	1.8706e+01	3.2964e+01	2.8024e-01	1.5965e+10
3.1176e-04	6.4880e-04	2.3497e+00	5.4989e+01	6.8403e-01	2.3490e+09
5.3724e-04	6.3831e-05	1.3246e+00	1.0084e+02	4.3375e-01	1.9255e+09
4.3605e-04	1.7612e-05	1.1858e+00	8.0381e+01	2.6591e-01	4.5215e+08
1.2856e-04	1.3864e-03	2.6428e+01	1.0053e+01	6.9576e-01	1.6269e+10
3.7982e-04	8.1901e-04	2.8127e+01	2.0403e+01	4.5799e-01	8.2700e+10
5.9932e-04	4.0310e-05	9.1711e-01	1.1251e+02	2.3804e-01	1.2787e+09
1.2007e-03	1.6551e-05	9.2651e-01	2.3120e+02	1.1381e-01	4.6820e+08
6.1701e-04	1.6467e-04	3.6255e+00	1.1174e+02	4.2779e-01	3.4883e+09
1.9167e-04	1.8920e-05	1.0585e+00	3.0901e+01	2.2579e-01	2.5296e+09
4.1009e-04	1.3883e-04	4.4927e+00	6.7593e+01	2.2752e+00	1.1539e+10
3.7462e-04	1.8445e-04	1.3833e+00	6.6300e+01	7.0099e-02	4.2400e+09
4.1728e-04	1.5651e-04	1.8629e+00	7.7295e+01	1.8209e-01	9.7304e+07
8.6358e-04	1.1476e-04	9.5819e-01	1.6348e+02	3.3499e-01	9.2203e+08
6.3043e-04	8.7216e-05	4.9139e+00	1.1836e+02	9.0040e-02	6.8157e+08
4.2670e-04	5.1777e-05	6.1716e-01	7.8508e+01	3.2799e-01	1.3824e+08
2.5267e-04	4.3111e-04	1.1915e+01	2.0523e+01	5.6209e-01	3.9388e+10
4.1075e-04	5.6980e-05	5.2919e+00	7.4541e+01	6.0313e-01	3.1060e+09
2.0342e-04	1.2130e-04	3.4521e+00	3.4321e+01	2.8666e-01	6.5420e+08
4.5511e-04	1.3246e-04	4.7503e+00	8.2621e+01	9.2039e-01	2.1298e+09
1.2561e-04	1.8973e-04	3.5888e+00	1.6041e+01	2.7671e-01	5.1802e+09
7.3566e-04	3.4937e-05	3.2929e+00	1.3830e+02	1.1592e-01	1.2898e+09
1.0185e-03	2.8570e-05	1.4589e+00	1.9251e+02	4.2110e-01	1.0724e+09
6.8886e-04	5.2198e-05	2.0741e+00	1.3107e+02	2.4404e-01	6.4604e+08
3.2967e-04	2.5815e-04	4.6461e+00	5.6824e+01	5.7887e-01	3.9510e+09
4.9831e-04	1.6556e-04	1.3355e+00	8.8988e+01	7.0508e-02	5.4197e+09
7.4207e-04	5.4685e-06	3.3309e-01	1.3994e+02	8.5281e-02	2.5521e+08
5.8076e-04	1.0136e-04	7.6705e-01	1.0725e+02	4.4831e-01	4.1839e+07

1.3841e-04	3.1595e-04	1.8237e+01	1.3843e+01	7.7255e-01	1.3093e+10
2.4115e-04	1.1689e-04	2.9992e+00	4.1342e+01	2.8214e-01	9.4813e+08
5.7476e-04	2.6364e-05	4.8032e-01	1.0927e+02	1.0448e-01	2.1617e+08
1.5718e-03	3.3767e-05	1.3071e+00	3.0506e+02	1.3481e-01	1.0638e+08
4.1995e-04	3.4258e-05	1.1721e+00	7.6682e+01	8.1878e-02	5.7920e+08
1.0041e-03	9.1446e-05	3.2225e+00	1.9031e+02	8.8626e-01	3.8651e+09
4.6285e-04	1.3624e-04	1.4255e+00	8.5799e+01	5.6421e-01	1.1462e+09
1.5916e-04	1.0432e-04	2.6768e+00	2.4433e+01	2.4521e-01	2.1433e+09
2.7481e-04	5.9169e-05	2.5396e+00	4.4160e+01	1.6180e-01	8.0234e+09
4.5298e-04	5.0793e-05	7.8425e-01	8.0897e+01	2.7057e-01	3.1753e+09
1.6225e-03	5.5675e-06	1.2202e+00	3.1476e+02	3.3994e-01	2.6671e+08
3.2134e-04	1.5977e-04	3.8637e+00	5.6359e+01	1.9451e-01	2.5824e+09
4.4145e-04	6.3279e-05	1.0398e+01	7.8537e+01	1.1329e+00	5.7154e+09
3.5882e-04	1.2886e-03	1.0157e+01	5.9832e+01	4.3939e-01	1.0555e+10
4.1342e-04	1.8244e-04	4.7162e+00	7.5720e+01	3.4818e-01	2.0080e+09
1.7498e-03	1.1529e-05	1.4807e+00	3.3511e+02	1.5354e-01	2.2899e+09
3.7763e-04	6.4196e-05	1.7645e+00	6.6861e+01	5.9917e-01	3.3000e+09
3.0471e-04	5.1007e-05	1.6179e+00	5.3971e+01	7.6537e-01	1.1720e+09
1.7839e-04	8.0559e-05	1.5698e+00	2.9600e+01	8.0062e-01	5.6965e+08
5.6704e-04	1.3111e-04	3.9024e+00	1.0207e+02	2.3728e-01	8.3323e+09
8.0711e-04	5.3499e-05	4.9590e-01	1.5262e+02	1.7779e-01	2.8080e+08
1.5797e-03	4.5181e-05	1.0173e+00	3.0476e+02	1.0310e-01	1.4753e+09
3.8736e-04	1.9134e-04	3.9394e+01	2.8463e+01	7.3899e-01	7.3367e+10
2.2804e-04	4.5251e-05	9.4612e-01	3.8646e+01	1.7514e+00	8.0012e+08
1.7541e-04	1.2310e-04	7.7867e+00	2.2401e+01	5.6923e-01	1.1168e+10
2.0948e-04	4.6565e-05	2.6515e+00	2.4864e+01	6.3876e-01	1.7842e+10
4.8028e-04	6.0916e-05	2.5388e+00	8.6257e+01	2.2255e-01	5.7783e+09
1.5861e-04	2.1413e-04	7.1542e+00	2.5249e+01	5.6683e-01	1.4269e+09
5.6888e-04	2.6115e-04	7.2577e+00	9.9835e+01	1.7949e+00	1.0194e+10
2.2185e-04	1.2074e-03	1.3182e+01	7.6855e+00	3.6228e-01	5.2378e+10
2.8673e-04	1.6192e-04	7.3591e+00	5.0121e+01	6.6531e-01	1.7424e+09
4.0942e-04	1.8500e-05	9.6835e-01	7.4763e+01	1.0635e-01	1.1792e+09
1.4307e-04	1.3623e-04	5.9459e+00	1.9837e+01	2.2544e-01	4.6420e+09
1.5493e-04	1.8914e-03	1.0385e+01	9.6519e+00	6.3449e-01	2.5215e+10
4.5499e-04	5.4591e-05	6.9243e+00	7.9746e+01	1.2558e-01	7.1629e+09
1.6794e-03	8.1294e-06	5.6595e-01	3.2579e+02	1.4615e-01	8.1537e+08
8.6972e-04	6.1988e-04	6.6960e+01	1.4736e+01	7.1864e-01	2.4747e+11
6.3561e-04	3.4850e-04	2.3023e+00	1.0882e+02	3.5376e-01	1.8008e+10
1.6709e-04	5.2026e-05	4.1959e+00	2.2570e+01	3.6479e-01	7.5964e+09
1.8890e-04	6.1846e-05	2.0705e+00	3.1396e+01	1.3351e+00	1.1373e+09
2.4197e-04	1.4126e-05	3.7618e+00	4.1522e+01	1.7638e-01	7.3876e+08
6.8654e-04	3.7636e-04	4.9852e+00	1.2551e+02	1.5510e+00	8.9841e+09
2.4408e-04	1.9500e-04	2.0835e+00	3.4748e+01	5.9547e-01	1.2738e+10
1.5006e-04	1.2236e-04	3.2454e+00	2.1613e+01	2.1289e-01	4.2242e+09
1.9127e-03	1.8006e-05	7.8482e-01	3.6924e+02	2.8121e-01	5.6760e+08
2.5510e-03	6.1031e-05	5.7330e-01	4.9795e+02	2.5489e-01	1.9676e+08
1.7226e-04	1.4989e-04	1.8574e+00	2.6771e+01	1.5049e+00	2.8456e+09
2.3696e-04	1.4738e-04	2.1651e+00	3.2925e+01	8.6244e-01	1.3689e+10
2.4513e-04	3.1874e-05	1.5141e+00	4.0547e+01	4.7983e-01	4.6654e+09
1.4522e-04	3.2177e-04	3.9146e+01	1.2905e+01	4.0391e-01	1.7085e+10
5.0953e-04	6.2446e-05	3.4127e-01	9.6999e+01	2.3932e-01	3.1320e+08
2.3628e-04	2.4212e-04	1.8678e+01	1.5677e+01	1.6244e+00	4.2215e+10
2.1617e-04	9.0419e-05	1.8568e+00	3.6511e+01	7.5980e-01	1.4292e+09
2.2422e-04	2.5981e-04	6.4916e+00	3.7576e+01	4.6643e-01	7.9193e+08
5.3617e-04	3.5906e-04	4.5242e+00	9.9323e+01	7.1978e-01	1.6216e+09
3.4499e-04	2.0897e-03	4.1760e+01	3.9308e+01	3.5622e+00	3.9263e+10
5.6746e-04	2.8590e-05	1.9532e+00	1.0650e+02	4.5089e-01	1.3493e+09
1.1607e-04	1.8907e-04	6.9048e+00	1.0594e+01	1.1982e+00	1.1228e+10
9.7560e-04	4.1959e-05	4.1287e-01	1.8726e+02	7.1720e-02	4.6861e+08
6.4169e-04	1.0823e-05	2.2978e+00	1.1995e+02	3.1652e-01	2.2629e+09
1.0442e-04	4.5950e-04	1.0162e+01	1.1789e+01	4.9881e+00	5.5451e+09
3.4178e-04	1.1359e-04	1.5132e+01	2.8911e+01	3.4480e-01	5.5602e+10
2.6290e-04	5.1765e-05	1.3229e+01	4.5514e+01	8.4287e-01	2.1123e+09
1.2297e-04	1.8446e-04	8.5614e+00	7.1238e+00	4.6096e-01	1.9151e+10
5.1007e-04	8.1468e-06	5.0459e-01	9.5721e+01	1.3185e-01	2.6936e+08
3.3411e-03	1.8999e-05	6.1485e-01	6.4756e+02	3.0084e-01	7.4873e+07
1.5786e-04	3.5520e-04	3.3675e+00	2.5016e+01	1.7623e-01	1.6715e+09
5.6338e-04	2.9232e-04	9.9759e+00	1.0234e+02	3.5321e-01	6.3576e+09
4.8351e-04	2.4532e-05	3.1575e-01	9.0810e+01	6.8527e-02	3.1803e+08
8.4204e-04	3.7739e-06	5.3399e-01	1.6213e+02	1.5582e-01	3.1593e+08
5.2062e-04	2.1497e-04	4.8069e+00	9.6308e+01	1.3324e+00	1.4935e+09
5.9327e-04	3.5029e-05	4.5930e+00	1.0971e+02	2.3400e-01	2.7283e+09
3.7017e-04	4.5472e-04	3.4007e+01	1.6785e+01	2.0495e+00	8.4913e+10
5.9861e-04	8.1745e-05	5.7380e+00	1.1163e+02	1.5389e-01	6.4502e+08
3.3074e-04	4.2396e-05	6.6152e-01	5.9026e+01	6.7224e-01	6.9705e+08
2.2313e-04	8.4090e-06	1.1574e+00	3.7281e+01	3.5712e-01	1.3219e+09
4.9181e-04	6.3392e-04	1.0141e+01	9.0136e+01	7.2851e-01	2.9822e+09
2.6651e-04	1.9362e-04	4.0558e+00	3.7075e+01	8.4129e-01	1.6324e+10
1.9585e-04	3.2289e-04	2.0346e+01	1.2375e+01	4.1071e-01	3.4864e+10
4.2109e-04	2.4020e-04	3.1417e+00	7.2948e+01	1.9657e-01	7.8481e+09
2.3243e-04	4.1918e-04	1.9708e+01	2.9578e+01	9.5729e-01	1.7947e+10
4.0809e-04	4.0856e-04	1.0419e+01	1.5927e+01	3.5344e+00	9.7431e+10
7.0303e-04	5.3620e-05	1.5190e+00	1.3341e+02	3.5101e-01	9.4712e+07
2.9509e-04	4.3594e-04	1.0976e+01	4.6258e+01	2.0109e+00	1.0432e+10
5.0214e-04	1.4793e-04	2.0164e+01	4.2741e+01	3.6660e-01	8.6770e+10
1.0243e-03	2.3938e-05	2.9324e-01	1.9380e+02	6.9888e-02	8.6802e+08
2.2195e-04	9.0090e-05	9.3382e+00	2.6605e+01	5.7809e-01	2.0383e+10

3.6348e-04	2.8498e-04	3.1142e+01	2.1401e+01	4.1218e-01	7.8155e+10
2.5323e-04	4.7352e-04	1.1902e+01	5.1645e+00	2.2282e+00	6.4216e+10
3.7929e-04	1.3855e-04	3.2290e+00	4.0600e+01	8.1306e-01	4.8963e+10
4.2167e-04	3.2580e-04	3.5912e+00	5.9335e+01	1.3838e-01	2.9887e+10
3.3635e-04	9.9812e-05	1.2266e+00	6.0492e+01	5.5832e-01	5.6664e+08
1.3625e-03	5.6767e-06	3.8404e-01	2.5799e+02	9.1895e-02	6.8462e+08
7.2303e-04	7.9774e-05	2.4213e+00	1.3559e+02	9.2458e-01	2.9531e+09
3.2156e-04	5.9495e-04	1.0154e+01	4.8336e+01	6.5300e-01	1.5804e+10
9.0545e-04	4.8626e-05	1.0516e+00	1.7193e+02	7.5291e-02	2.7707e+08
1.4275e-04	1.2665e-04	4.8641e+00	1.3030e+01	8.9738e-01	1.5839e+10
3.0024e-04	3.3034e-04	4.4676e+00	4.9444e+01	8.3390e-02	6.4833e+09
2.7824e-04	3.9130e-04	1.4447e+01	3.9723e+01	4.6867e-01	1.5870e+10
3.9458e-04	5.7178e-04	1.1229e+01	4.3356e+01	9.5814e-01	4.7533e+10
1.3471e-04	9.1756e-05	1.2076e+01	1.8581e+01	2.3788e-01	3.5626e+09
3.2606e-04	2.7815e-05	1.3448e+01	5.6632e+01	2.2924e+00	4.0305e+09
3.7229e-04	1.4860e-04	9.4384e+00	6.6431e+01	4.9841e-01	2.0383e+09
1.8729e-04	8.6782e-05	5.2019e+00	3.0882e+01	2.3964e-01	3.6419e+08
7.5299e-04	7.0827e-05	1.0801e+00	1.3949e+02	8.2604e-01	5.0749e+09
5.2090e-04	9.3216e-05	1.3992e+01	9.1097e+01	9.3344e-01	6.7565e+09
2.2969e-04	1.5851e-04	8.8698e+00	3.5848e+01	4.6112e-01	6.5313e+09
3.7019e-04	2.2444e-05	4.9965e+00	6.5285e+01	9.1064e-02	2.4922e+09
8.1936e-04	2.1739e-05	2.0981e+00	1.5782e+02	4.9522e-01	2.1889e+08
2.7395e-04	3.6139e-04	5.4049e+00	4.3007e+01	3.4270e+00	7.9129e+09
7.9632e-04	2.2638e-05	4.2348e-01	1.5154e+02	5.6229e-02	6.0559e+08
1.2122e-03	9.8120e-05	8.6233e-01	2.3352e+02	3.4112e-01	2.5680e+08
4.5876e-04	8.2362e-05	1.8168e+00	8.5711e+01	1.1760e+00	4.2730e+08
9.6091e-04	8.2419e-05	2.7602e+00	1.8238e+02	1.8206e-01	3.2241e+09
1.2370e-03	1.3227e-03	2.7306e+01	8.1347e+00	1.7945e+00	4.0184e+11
8.4491e-04	4.8698e-05	6.1343e-01	1.6176e+02	3.1251e-01	7.7760e+08
3.4193e-04	5.1154e-05	4.8063e+00	5.9169e+01	7.6988e-01	3.1821e+09
1.9660e-04	5.3670e-05	1.7238e+01	3.0444e+01	2.5852e-01	4.5816e+09
1.8801e-04	9.0590e-05	4.5767e+00	2.1580e+01	7.9257e-01	1.6679e+10
4.4383e-04	2.9199e-04	2.9617e+00	7.9537e+01	2.2393e-01	5.2072e+09
1.7701e-04	5.6832e-05	3.9600e+00	2.8424e+01	1.7686e-01	1.6638e+09
3.0892e-04	4.5168e-04	5.5394e+00	3.6947e+01	1.8355e-01	3.0298e+10
1.8166e-04	3.4334e-04	2.5614e+01	1.7317e+01	6.9524e-01	2.1870e+10
2.2639e-04	1.4162e-04	4.2373e+00	3.3657e+01	5.2507e-01	8.9550e+09
7.7950e-04	3.0016e-06	6.4005e-01	1.4727e+02	7.6568e-02	2.2780e+08
2.7901e-04	8.6227e-05	3.2085e+00	4.3848e+01	2.3094e+00	9.2687e+09
5.8663e-04	1.5800e-04	2.2453e+00	1.0926e+02	2.8460e-01	1.2604e+09
1.3328e-03	1.3292e-04	7.3485e-01	2.5586e+02	8.4726e-02	8.0526e+08
6.5420e-04	6.2070e-05	4.2447e-01	1.2158e+02	1.7938e-01	1.7390e+09
3.3113e-04	1.4450e-04	5.1910e+00	5.9075e+01	6.5431e-01	7.6387e+08
1.4468e-04	2.0613e-03	6.6953e+00	2.1218e+01	1.1326e+00	2.7798e+09
3.9413e-04	2.9687e-04	1.9827e+01	8.8978e+00	1.2743e+00	1.0579e+11
8.5198e-04	1.0314e-04	3.3715e+00	1.6071e+02	9.7713e-01	1.1664e+09
4.3692e-04	1.2358e-05	7.9735e-01	7.9508e+01	2.8462e-01	3.4653e+08
3.4097e-04	6.3647e-04	5.6218e+01	1.7136e+01	9.7493e-01	7.3832e+10
9.9637e-04	1.2260e-05	8.5048e-01	1.9088e+02	2.1396e-01	1.1539e+08
3.9079e-04	7.6193e-05	2.6044e+00	7.1042e+01	9.9755e-01	1.1096e+09
2.2690e-04	9.3660e-04	5.7848e+00	1.0231e+01	7.0450e-01	4.8623e+10
2.8306e-04	8.0235e-05	2.0841e+00	4.9642e+01	2.0384e+00	5.8564e+08
2.6160e-04	1.1247e-04	4.4214e+00	4.3099e+01	5.3456e-01	4.0084e+09
3.4313e-04	8.9948e-05	2.2768e+00	6.1462e+01	7.1682e-01	1.1789e+09
4.5581e-04	1.2063e-04	3.5732e+00	7.7867e+01	3.5278e-01	9.1585e+09
4.3081e-04	1.9541e-04	2.8425e+01	5.1335e+01	9.4085e-01	4.6453e+10
2.1585e-04	4.7111e-05	1.2018e+00	3.5888e+01	3.2452e-01	1.2520e+09
2.6710e-04	3.9645e-04	4.1486e+01	3.0653e+01	1.9604e+00	2.7775e+10
2.7041e-04	1.5891e-04	1.9610e+00	4.7407e+01	1.9660e-01	8.1272e+08
9.5981e-05	7.3030e-04	1.3313e+01	5.8300e+00	1.1353e+00	1.2964e+10
6.6611e-04	9.3470e-04	1.6244e+01	1.5148e+01	9.7813e-01	1.7807e+11
1.9681e-04	1.3156e-04	7.0082e+00	2.2389e+01	2.3862e+00	1.8079e+10
1.3615e-04	5.1118e-04	1.5571e+01	1.2174e+01	5.8098e-01	1.5675e+10
2.1983e-04	7.1542e-05	3.7815e+00	3.6143e+01	2.2617e-01	2.4822e+09
4.3498e-04	3.5499e-04	3.5441e+01	1.7043e+01	3.6510e+00	1.0517e+11
2.3582e-04	6.4117e-04	1.0697e+01	3.6229e+01	3.8575e-01	7.7798e+09
4.3534e-04	3.7209e-04	1.2932e+01	6.0404e+01	9.2905e-01	3.3117e+10
9.9258e-05	1.1044e-03	3.7970e+01	5.4827e+00	5.2999e-01	1.4260e+10
3.9192e-04	4.2170e-04	1.6827e+00	7.0690e+01	4.0623e-01	2.6063e+09
5.5484e-04	7.5158e-05	6.9282e-01	1.0346e+02	1.4734e-01	1.7615e+09
8.5389e-04	1.0763e-04	3.3771e+00	1.6162e+02	1.5664e-01	4.1543e+08
1.8498e-04	5.2626e-05	1.0776e+01	2.7812e+01	1.3223e+00	5.8459e+09
1.4408e-04	8.5163e-05	2.1334e+00	1.8476e+01	1.0136e-01	6.7959e+09

Contents

BMED 3310 Computational Project - Part 2

```
clear
close all
clc
```

Load in Project Data

```
[redacted]
```

Scaling and preparing data for fitting

```
[redacted]
```

Multilinear fit

Here we will perform a multilinear fit using two different methods

```
% Perform multilinear fit using fitlm
MultilinearMdl = fitlm([redacted];
disp(MultilinearMdl);

% Perform multiplinear fit using fitnlm
[redacted]
disp(MultilinearMdl_2);
```

```
Linear regression model:
    y ~ 1 + x1 + x2 + x3 + x4 + x5

Estimated Coefficients:
                   Estimate       SE        tStat       pValue
                   ________    ________    ________    ________

    (Intercept)    [redacted]
    x1
    x2
```

```
    x3
    x4      [redacted]
    x5

Number of observations: 200, Error degrees of freedom: 194
Root Mean Squared Error: 0.00169
R-squared: 1,  Adjusted R-Squared: 1
F-statistic vs. constant model: 2.63e+05, p-value = 0

Nonlinear regression model:
    y ~ F(b,x)

Estimated Coefficients:
          Estimate       SE        tStat       pValue
          ________    ________    ________    ________

    b1
    b2
    b3    [redacted]
    b4
    b5
    b6

Number of observations: 200, Error degrees of freedom: 194
Root Mean Squared Error: 0.00169
R-Squared: 1,  Adjusted R-Squared 1
F-statistic vs. constant model: 2.63e+05, p-value = 0
```

Exponential fit

```
[redacted]
disp(ExponentialMdl);
```

```
Nonlinear regression model:
    y ~ F(b,x)

Estimated Coefficients:
          Estimate       SE        tStat       pValue
          ________    ________    ________    ________

    b1
    b2
    b3    [redacted]
    b4
    b5
    b6

Number of observations: 200, Error degrees of freedom: 194
Root Mean Squared Error: 0.0515
```

```
R-Squared: 0.863,  Adjusted R-Squared 0.86
F-statistic vs. zero model: 488, p-value = 4.16e-114
```

Power fit

[redacted]

```
disp(PowerMdl);
```

```
Nonlinear regression model:
    y ~ F(b,x)

Estimated Coefficients:
          Estimate        SE        tStat       pValue
          ________    ________    ________    ________

    b1
    b2
    b3
    b4
    b5
    b6
```

[redacted]

```
Number of observations: 200, Error degrees of freedom: 194
Root Mean Squared Error: 0.0395
R-Squared: 0.919,  Adjusted R-Squared 0.917
F-statistic vs. zero model: 850, p-value = 2.39e-136
```

Contents

BMED 3310 Computational Project - Part 3

```
clear
close all
clc
```

Load in Project Data

Check the accuracy of your starting data

[redacted]

Unscaling Coefficients

Here we will unscale the multi-linear, exponential, and power regression model coefficients

```
% Multi-linear unscaling
[redacted]
disp(Multilinear_coefficients_unscaled);

% Exponential unscaling
[redacted]
disp(Exponential_coefficients_unscaled);

% Power unscaling
[redacted]
disp(Power_coefficients_unscaled);
```

```
                                                    Estimate
                                                    ________

    (Intercept)                                     [redacted]
    Pi[Mass 1]
    Pi[Time 1]
    Pi[Velocity 1]
    Pi[Volume 1]
    Pi[Volumetric Thermal Expansion Coefficient 1]

                                                    Estimate
```

```
(Scale Factor)
Pi[Mass 1]
Pi[Time 1]
Pi[Velocity 1]
Pi[Volume 1]
Pi[Volumetric Thermal Expansion Coefficient 1]
```

[redacted]

```
            Estimate
            ________

(Scale Factor)
Pi[Mass 1]
Pi[Time 1]
Pi[Velocity 1]
Pi[Volume 1]
Pi[Volumetric Thermal Expansion Coefficient 1]
```

[redacted]

Choosing the Best Fit

```
fprintf([redacted]
```

```
The AIC value of the multilinear model is: -1979.707075
The AIC value of the exponential model is: -613.214238
The AIC value of the power model is: -718.915889
The best model is _____ because ______
```

Identify Critical Pi Groups

```
fprintf([redacted]
```

```
Critical pi groups were identified based on ______
The non-basis associated with the critical pi groups are Velocity 1 and [redacted]
```

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