

# DS 203

## COURSE OVERVIEW



Semester 1  
2024-2025

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DS 203

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- Course title: ***Programming*** for Data Science
- Course structure (L-T-P-C): 0-2-2-6
- Tutorials : Classes, typically ‘show and tell’
- Practicals: Assignment based
- *Guest Lectures: 1 – 2 session(s) by experienced Professionals*
- Assignments : About 10 ... major and minor
- Self study : 5 hours per week

# DS 203

Assignments	<ul style="list-style-type: none"><li>• 8 - 10</li><li>• Every submission will be reviewed for completeness and correctness</li><li>• There will be penalties for late / no / fraudulent submissions</li></ul>
Evaluation scheme	<ul style="list-style-type: none"><li>• 10% : 2 surprise quiz</li><li>• 30% : Mid-semester test</li><li>• 30% : Project (Group Project, max 4 members)</li><li>• 30% : End-semester</li></ul>
Penalties	<ul style="list-style-type: none"><li>• (-1) : Late / non submission of assignments (each event)</li><li>• (-10) : Copying assignments / project (each event)</li><li>• (-10) : Fraudulent assignment submissions (each event)</li><li>• The penalty will be in addition to zero credit (where applicable) for that particular submission</li></ul>
Attendance	<ul style="list-style-type: none"><li>• As per IITB rules for attendance (self regulated)</li><li>• No attendance will be taken in class, except during quiz / test / examination</li></ul>

- SAFE app, Forms (Google / PDF), Moodle may be used
- **Paper** option will always be available as a standby
- Tests and exams
  - Will involve reasoning, programming
  - Will involve **application** of the knowledge and skill learnt through attending classes and doing the assignments
  - Will be, **most likely**, open – including internet access

# SAFE Application

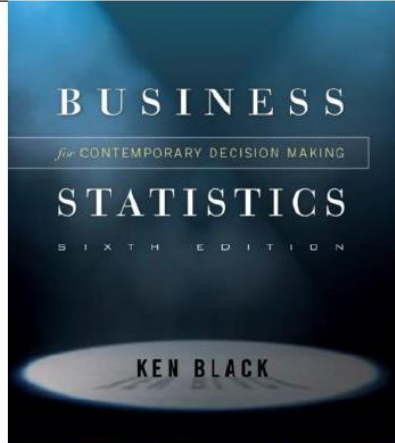
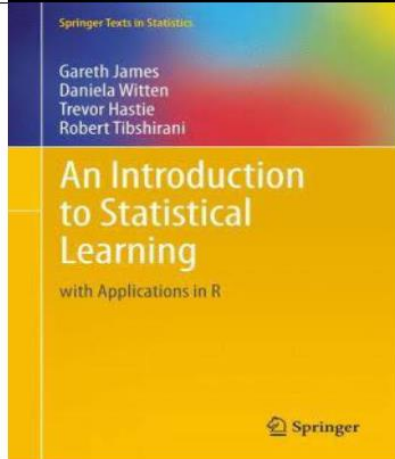
- SAFE app will be used for conducting quiz, and for marking attendance during the quiz
- All participants **should** compulsorily register themselves on SAFE app using the following registration code:

**20FLXYSI**

- You may mark your class attendance using the app (for your own records)
- In case of teething troubles, write to [safe@iitb.ac.in](mailto:safe@iitb.ac.in) and visit their office in the CC to get them resolved

# Books and References

- Learning Data Science : <https://learningds.org/intro.html>
- Veridical Data Science : <https://vdsbook.com/>

For topics related to Statistics	Business Statistics for Contemporary Decision Making  Author: Ken Black (Available online – 6 <sup>th</sup> Edition)	
For topics related to Machine Learning	An Introduction to Statistical Learning  Authors: Gareth James and others  (Available online)	



# Course Assets on Moodle

## Course Menu

### General

Announcements

Forum Group 1



Forum Group 2



Forum Group 3



Forum Group 4



Forum Group 5



### 1 August - 7 August ▾

### 8 August - 14 August ^

Install / Register yourself in SAF...

2023-08-09-Data-Science-Bac...

DS203-2023-08-09-Board.pdf

Simple Linear Regression Deriv...

linear-data-set-for-regression.csv

-data-set-for-regressi...



## 1 August - 7 August ▾



DS 203 - Course Overview

Mark as done



2023-08-02-Data-Science-Backgrounder

Mark as done



2023-08-04-Data-Science-Backgrounder-2

Mark as done



E1 - Pivot-Tables

Mark as done

**Opened:** Saturday, 5 August 2023, 12:00 AM

**Due:** Wednesday, 9 August 2023, 11:55 PM



# Data Science

# What is Data Science?

- Data science is a **broad field** that encompasses the overall process of **extracting insights** and **knowledge** from data. It involves **collecting, cleaning, organizing, analyzing, and interpreting data** to uncover **patterns, trends, and meaningful information**.
- Data science utilizes various techniques, methodologies, and tools to **extract valuable insights** from data.

# Case Study

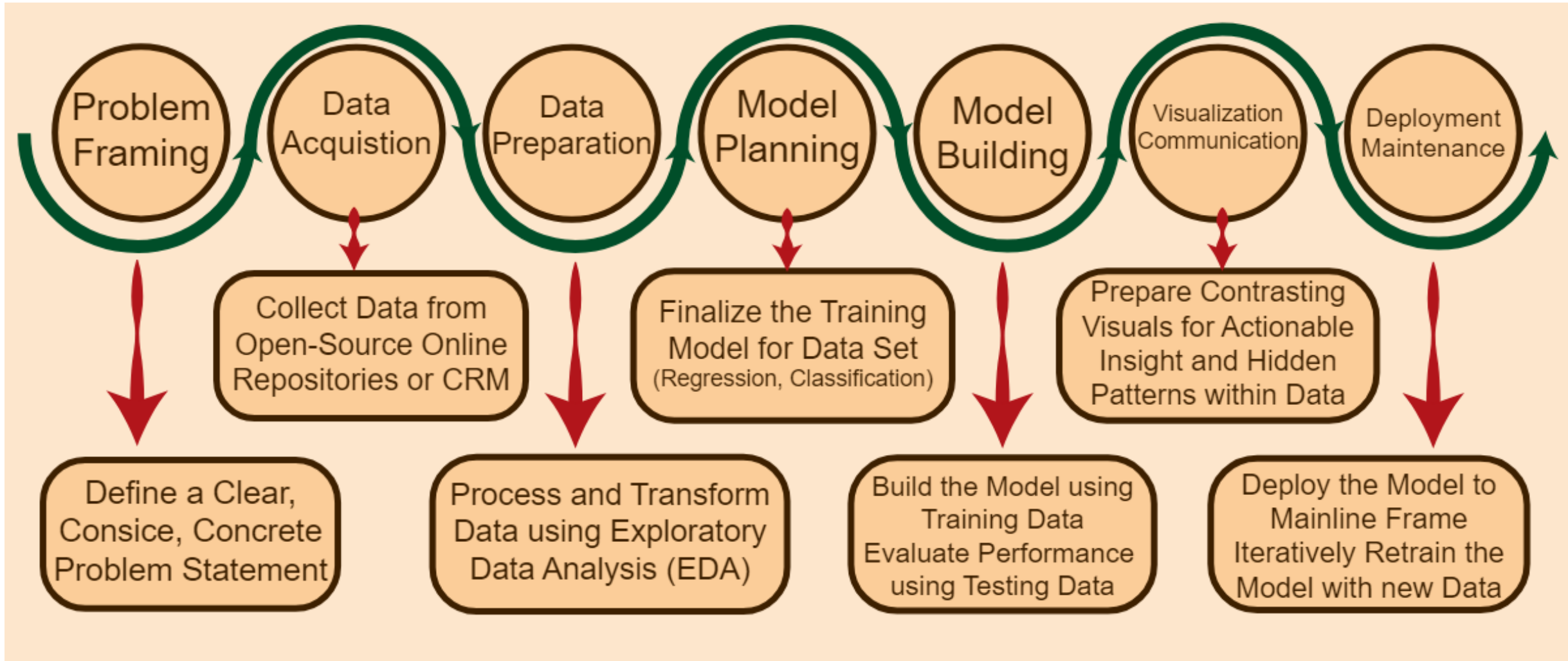
# Case Study Overview

Attribute	Details
The problem	Optimization of process(es) in a chemical plant
Goals	<ol style="list-style-type: none"><li>1. Operating parameters' optimization</li><li>2. Throughput prediction</li><li>3. Breakdown prediction</li><li>4. Predictive Maintenance of equipment</li></ol>
Basis	Multiple year, daily averages of operational parameters available from Data Acquisition System
Columns	132
Rows	2657 (approximately 7 years' daily averages data)

# The Data ...

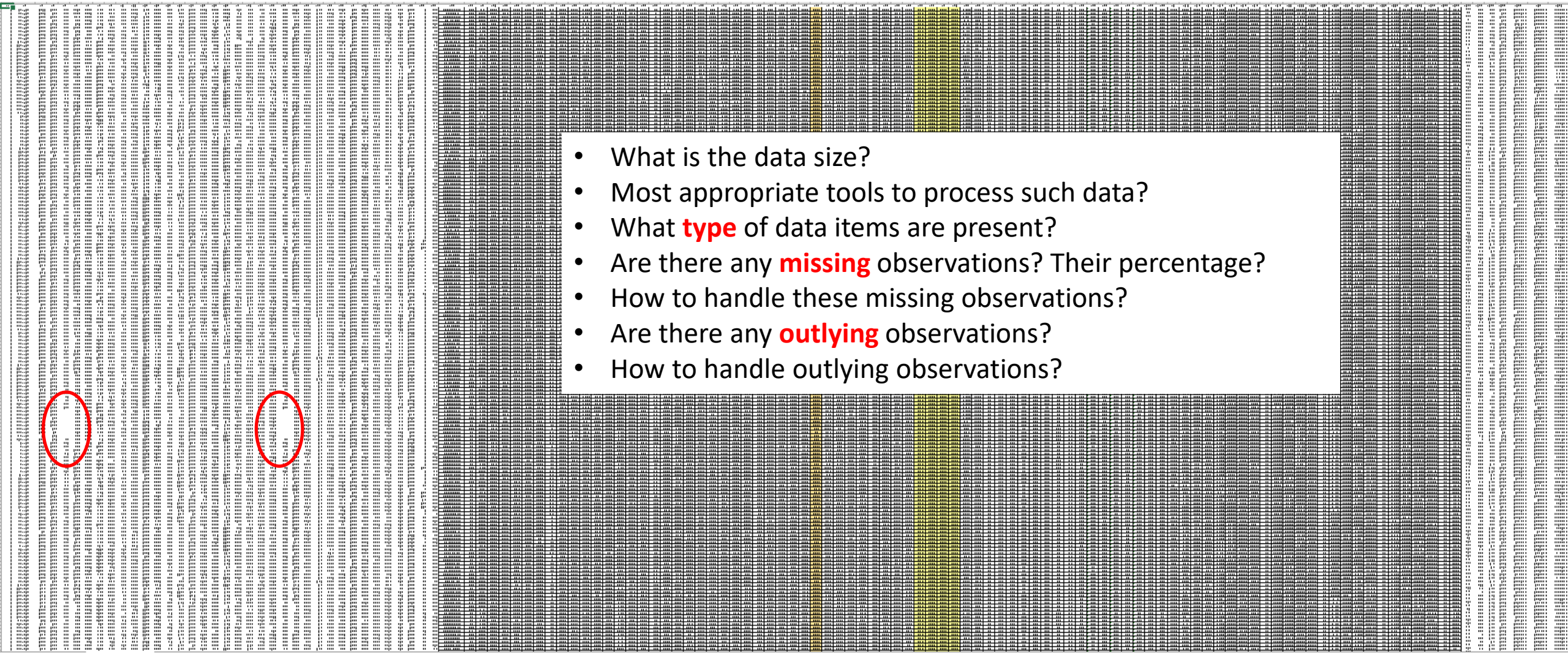
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# The Data Science Process



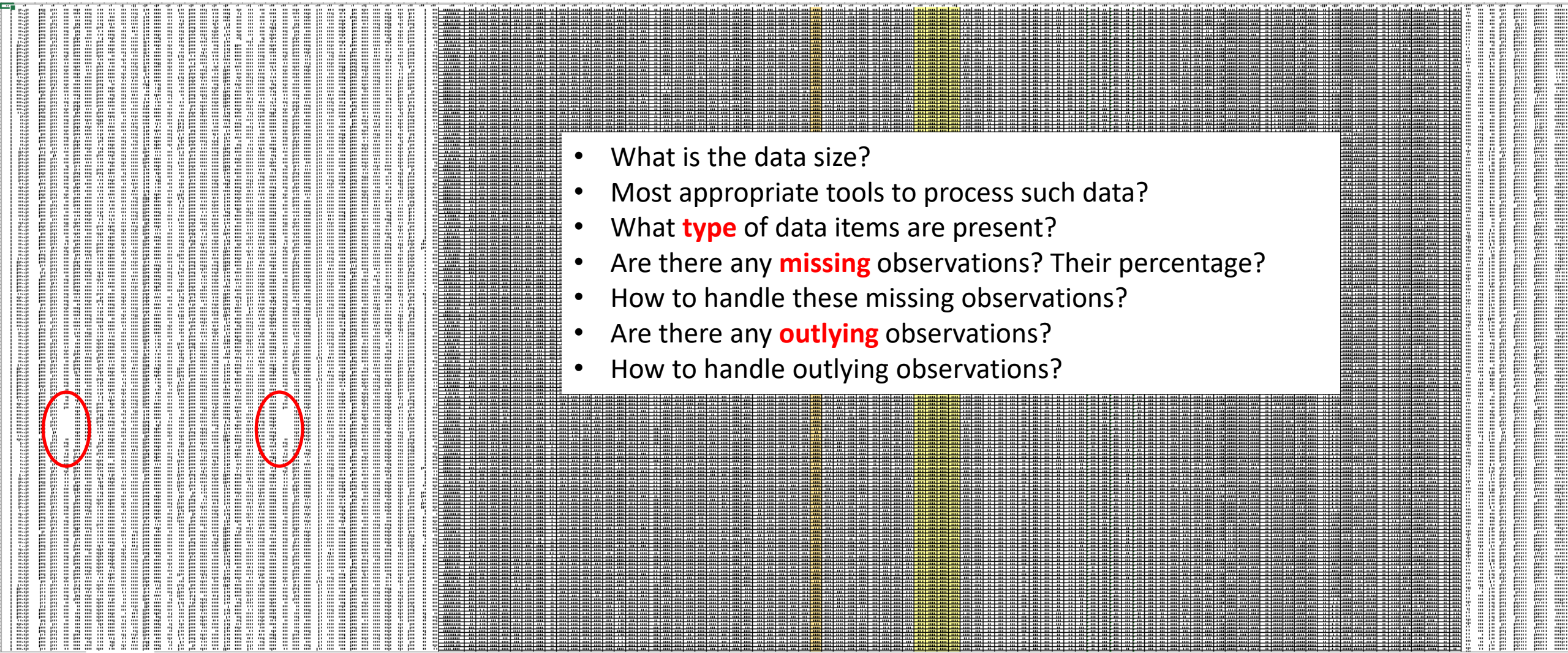


# Preliminary analysis of the Data



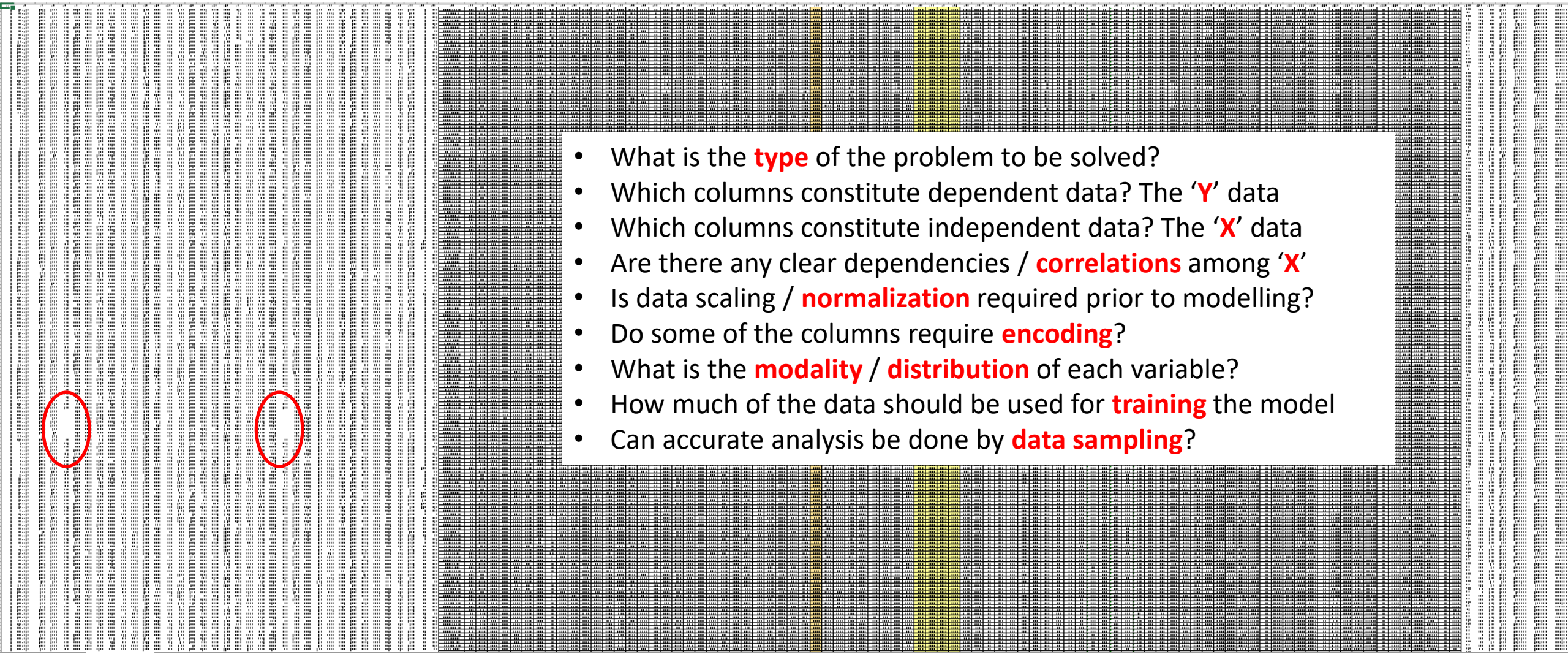
- What is the data size?
- Most appropriate tools to process such data?
- What **type** of data items are present?
- Are there any **missing** observations? Their percentage?
- How to handle these missing observations?
- Are there any **outlying** observations?
- How to handle outlying observations?

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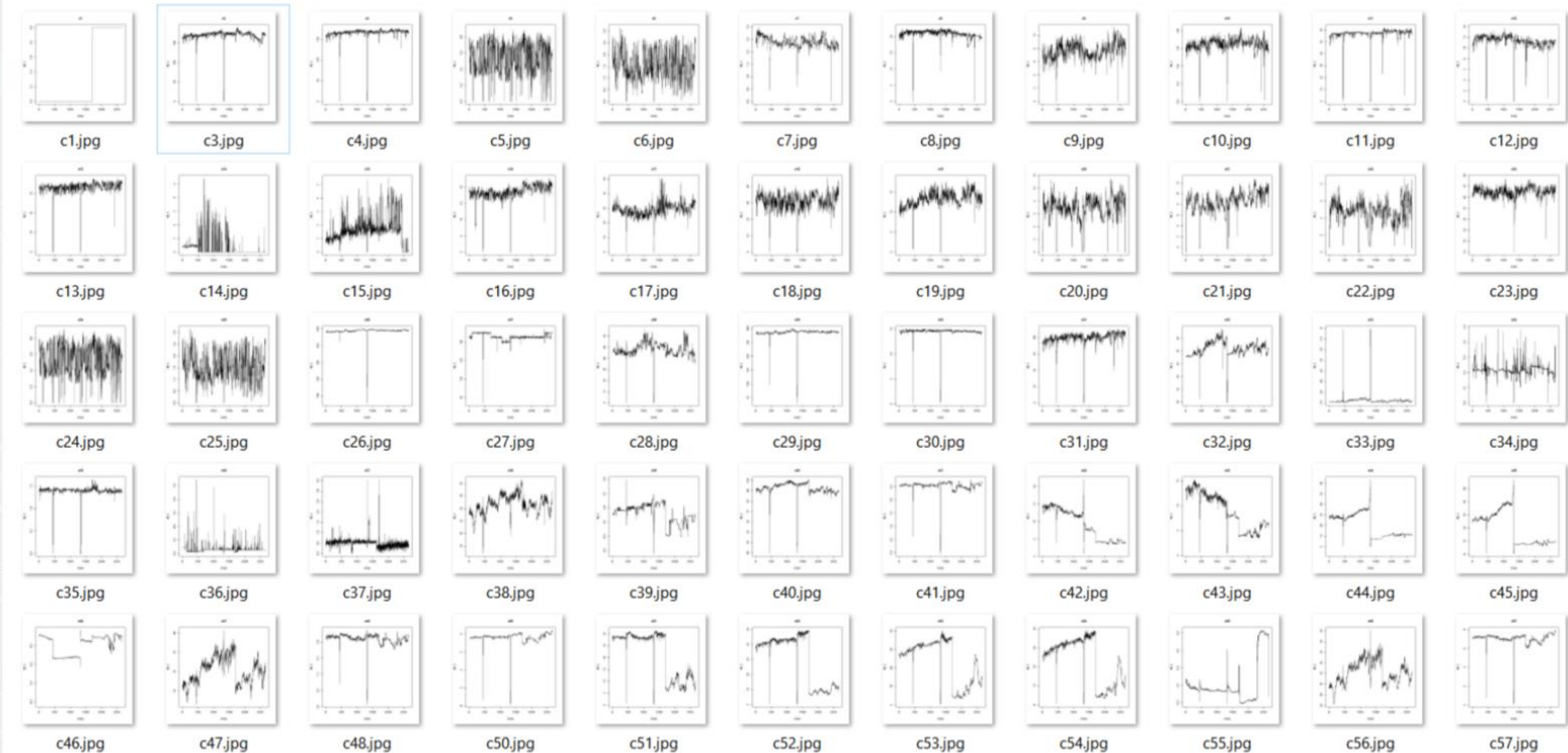
- # Preliminary analysis of the Data
- 
- What is the data size?
  - Most appropriate tools to process such data?
  - What **type** of data items are present?
  - Are there any **missing** observations? Their percentage?
  - How to handle these missing observations?
  - Are there any **outlying** observations?
  - How to handle outlying observations?
- 16



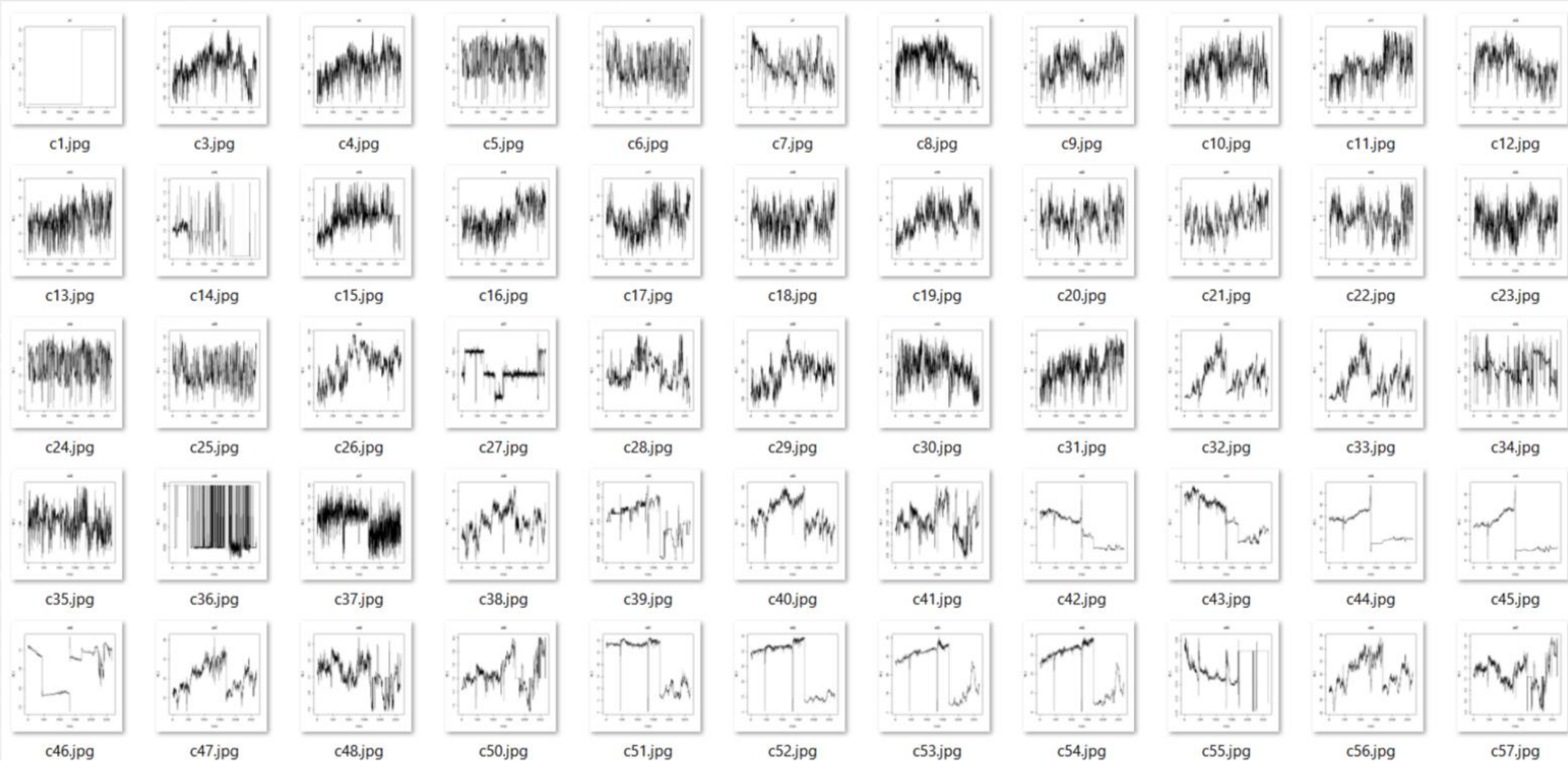
# Early analysis / decisions based on Data

- 
- What is the **type** of the problem to be solved?
  - Which columns constitute dependent data? The '**Y**' data
  - Which columns constitute independent data? The '**X**' data
  - Are there any clear dependencies / **correlations** among '**X**'
  - Is data scaling / **normalization** required prior to modelling?
  - Do some of the columns require **encoding**?
  - What is the **modality** / **distribution** of each variable?
  - How much of the data should be used for **training** the model
  - Can accurate analysis be done by **data sampling**?

# Data plots to understand trends / detect outliers

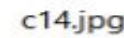
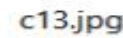
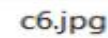
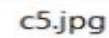
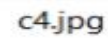


# Data plots after **processing** outliers

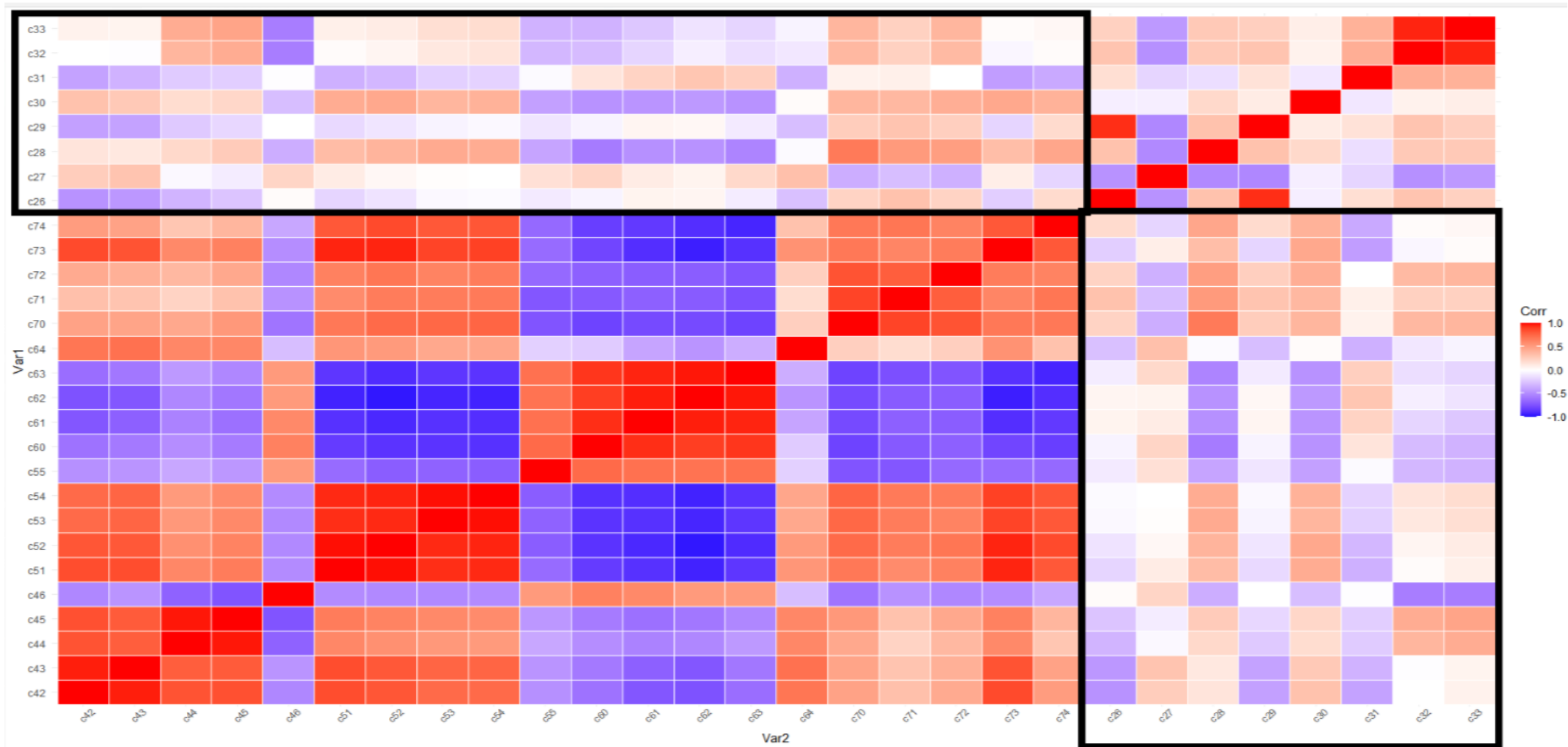




# Modality and Distributions



# Correlation between variables



# Use of Linear Regression to model and predict a parameter

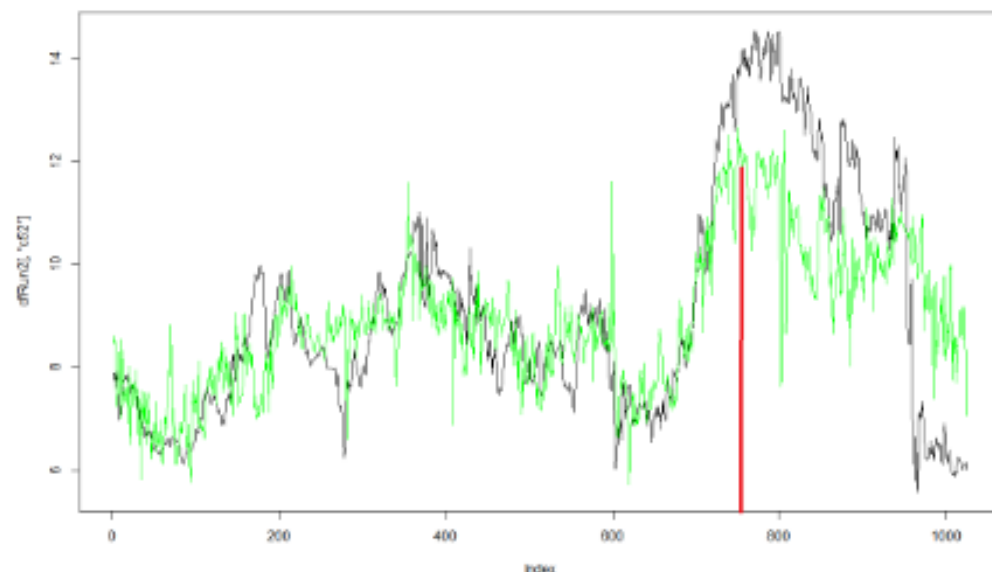
## Training: First 750 data points

### Coefficients:

	Estimate	Std. Error	t value	Pr(> t )	
(Intercept)	-16.209642	5.592980	-2.898	0.003866	**
c161	0.011909	0.001154	10.317	< 2e-16	***
c28	0.192089	0.031109	6.175	1.10e-09	***
c7	1.762212	0.244322	7.213	1.38e-12	***
c17	-0.099812	0.019082	-5.231	2.21e-07	***
c158	0.123261	0.018093	6.813	2.01e-11	***
c160	0.004787	0.001771	2.703	0.007041	**
c39	6.898476	1.100166	6.270	6.18e-10	***
c22	-0.104352	0.034339	-3.039	0.002460	**
c11	-0.122940	0.036342	-3.383	0.000756	***
c15	-0.371219	0.056582	-6.561	1.02e-10	***
c30	1.702216	0.337681	5.041	5.85e-07	***
c23	-0.274084	0.039142	-7.002	5.74e-12	***
c35	5.033540	1.451099	3.469	0.000554	***
c16	-0.381731	0.073873	-5.167	3.07e-07	***
c139	-0.221037	0.036769	-6.011	2.91e-09	***
c31	0.156248	0.022446	6.961	7.55e-12	***
c143	-0.236297	0.034607	-6.828	1.82e-11	***
c157	0.160972	0.038140	4.221	2.75e-05	***
c163	0.009764	0.002779	3.513	0.000471	***
c9	-0.267089	0.070883	-3.768	0.000178	***
c8	-0.369612	0.122558	-3.016	0.002652	**
c10	3.208038	1.541097	2.082	0.037723	*

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Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.8832 on 727 degrees of freedom  
Multiple R-squared: 0.6309, Adjusted R-squared: 0.6198  
F-statistic: 56.49 on 22 and 727 DF, p-value: < 2.2e-16



# Interpretation of results

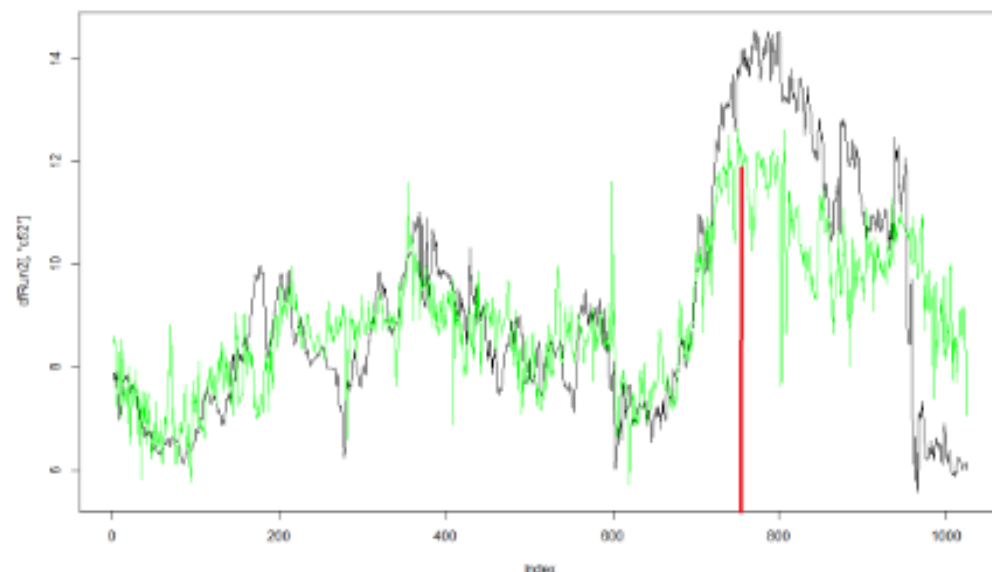
## Training: First 750 data points

Coefficients:

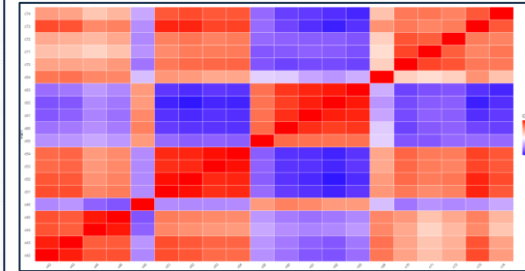
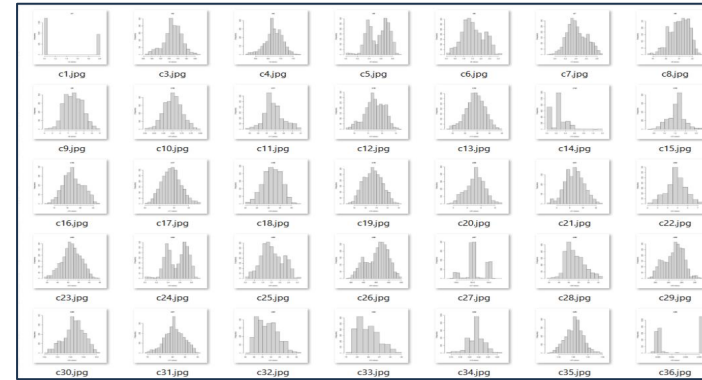
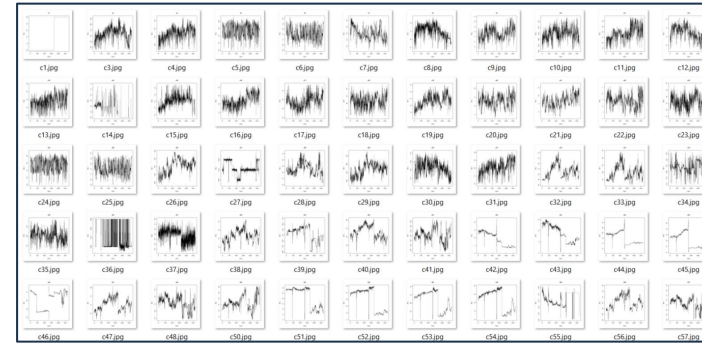
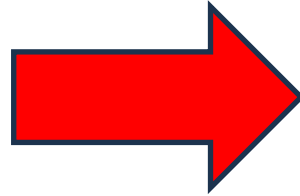
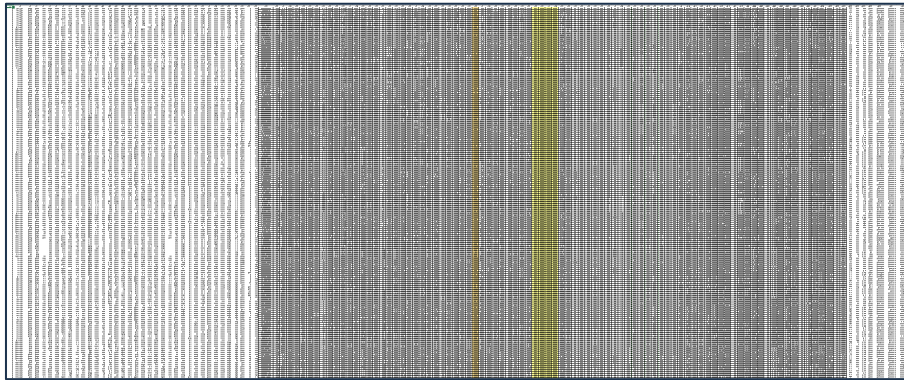
	Estimate	Std. Error	t value	Pr(> t )	
(Intercept)	-16.209642	5.592980	-2.898	0.003866	**
c161	0.011909	0.001154	10.317	< 2e-16	***
c28	0.192089	0.031109	6.175	1.10e-09	***
c7	1.762212	0.244322	7.213	1.38e-12	***
c17	-0.099812	0.019082	-5.231	2.21e-07	***
c158	0.123261	0.018093	6.813	2.01e-11	***
c160	0.004787	0.001771	2.703	0.007041	**
c39	6.898476	1.100166	6.270	6.18e-10	***
c22	-0.104352	0.034339	-3.039	0.002460	**
c11	-0.122940	0.036342	-3.383	0.000756	***
c15	-0.371219	0.056582	-6.561	1.02e-10	***
c30	1.702216	0.337681	5.041	5.85e-07	***
c23	-0.274084	0.039142	-7.002	5.74e-12	***
c35	5.033540	1.451099	3.469	0.000554	***
c16	-0.381731	0.073873	-5.167	3.07e-07	***
c139	-0.221037	0.036769	-6.011	2.91e-09	***
c31	0.156248	0.022446	6.961	7.55e-12	***
c143	-0.236297	0.034607	-6.828	1.82e-11	***
c157	0.160972	0.038140	4.221	2.75e-05	***
c163	0.009764	0.002779	3.513	0.000471	***
c9	-0.267089	0.070883	-3.768	0.000178	***
c8	-0.369612	0.122558	-3.016	0.002652	**
c10	3.208038	1.541097	2.082	0.037723	*

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.8832 on 727 degrees of freedom  
Multiple R-squared: 0.6309, Adjusted R-squared: 0.6198  
F-statistic: 56.49 on 22 and 727 DF, p-value: < 2.2e-16



# Goal of Data Science : **Extract Insights from Data**



Training: First 750 data points

Coefficients:

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-16.209642	5.502980	-2.898	0.003866 **
c163	0.011909	0.001154	10.317	< 2e-16 ***
c28	0.150089	0.031109	6.175	1.10e-09 ***
c7	1.762212	0.244322	7.213	1.38e-12 ***
c17	-0.099812	0.019082	-5.231	2.21e-07 ***
c158	0.123261	0.018093	6.813	2.01e-11 ***
c160	0.004787	0.001771	2.703	0.007041 **
c39	6.898476	1.100166	6.270	6.18e-10 ***
c22	-0.104352	0.034339	-3.039	0.002460 **
c11	-0.122940	0.036342	-3.383	0.000756 ***
c15	-0.371219	0.056382	-6.561	1.02e-10 ***
c30	1.702216	0.337681	5.041	5.85e-07 ***
c23	-0.274084	0.039142	-7.002	5.74e-12 ***
c35	5.033440	1.451099	3.469	0.000514 ***
c16	-0.381731	0.073873	-5.167	1.07e-07 ***
c139	-0.221051	0.036769	-6.012	2.91e-09 ***
c31	0.156248	0.022446	6.961	7.55e-12 ***
c143	-0.236297	0.034607	-6.828	1.82e-11 ***
c157	0.160972	0.038140	4.221	2.75e-05 ***
c163	0.009764	0.002779	3.513	0.000471 ***
c9	-0.267089	0.070883	-3.768	0.000178 ***
c8	-0.368612	0.122538	-3.016	0.002652 **
c10	3.208038	1.541097	2.082	0.037723 *

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.8832 on 727 degrees of freedom  
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