CCT College Dublin

Assessment Cover Page

Module Title:	Strategy Thinking
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Declaration

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Detection and Prediction Severe Slugging

Strategic Thinking Capstone Project

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Strategic Thinking Capstone Project

Higher Diploma in Science in Artificial Intelligence Applications
CCT College Dublin
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1 Introduction

Introduction to be inserted here

1.1 Business Understanding

1.1.1 Hypothesis

Hypothesis here

1.1.2 General Goal

Goal here

1.1.3 Success criteria/indicators

Success criteria/indicators here

1.1.4 Selected Processes and Technologies

Libraries, Models and machine learning algorithms.

1.1.5 Accomplishments

- Extracted and prepared data from Petrobras 3W
- Two models with a very high accuracy (Random Forest and Decision Tree)

2 Data Understanding

Preprocessing a dataset through data characterisation involves summarising the features and characteristics present in the data using statistical measures and visualisations techniques such as bar charts and scatter plots. After this stage, it should be possible to identify biases, patterns, trends, and any missing or irrelevant data in the data set that may need to be addressed.

This dataset is composed by instances of eight types of undesirable events characterized by eight process variables from three different sources: real instances, simulated instances and hand-drawn instances. All real instances were taken from the plant information system that is used to monitor the industrial processes at an operational unit in Brazilian state of Espírito Santo. The simulated instances were all generated using https://www.software.slb.com/products/olga, a dynamic multiphase flow simulator that is widely used by oil companies worldwide (Andreolli, 2016). Finally, the hand-drawn instances were generated by a specific tool developed by Petrobras researchers for this dataset to incorporate undesirable events classfied as rare.

Ultimately, only the data from the real instances were select for this project, as simulated data and hand-drawn instances did not present any record for two relevant features, namely Gas Lift Flow Rate and Pressure Variable Upstream Of the Gas Lift Choke.

2.1 Data Characterisation

The data consists of over 50 million observations, with 13 columns of data for each observation. The first column, label, indicates the event type for each observation. The second column, well, contains the name of the well the observation was taken from. Hand-drawn and simulated instances have fixed names for in this column, while real instances have names masked with incremental id. The third column, id, is an identifier for the observation and it is incremental for hand-drawn and simulated instances, while each real instance has an id generated from its first timestamp. The columns representing the process variables are:

- P-PDG: pressure variable at the Permanent Downhole Gauge (PDG) - installed on Christmas Tree;

- P-TPT: pressure variable at the Temperature and Pressure Transducer (TPT) - installed on Christmas Tree;
- T-TPT: temperature variable at the Temperature and Pressure Transducer (TPT);
- P-MON-CKP: pressure variable upstream of the production choke (CKP) - located on platform;
- T-JUS-CKP: temperature variable downstream of the production choke (CKP);
- P-JUS-CKGL: pressure variable upstream of the gas lift choke (CKGL);
- T-JUS-CKGL: temperature variable upstream of the gas lift choke (CKGL);
- QGL: gas lift flow rate;

The pressure features are measured in Pascal (Pa), the volumetric flow rate features are measured in standard cubic meters per second (SCM/s), and the temperature features are measured in degrees Celsius (°C).

Other information are also loaded into each pandas Dataframe:

- label: instance label (event type) - target variable;
- well: well name. Hand-drawn and simulated instances have fixed names (respectively, drawn and simulated. Real instances have names masked with incremental id;
- id: instance identifier. Hand-drawn and simulated instances have incremental id. Each real instance has an id generated from its first timestamp;
- class: Although it can be used to identify periods of normal operation, fault transients, and faulty steady states, which can help with diagnosis and maintenance, it is a category which results from label, which is our target here

The labels are:

- 0 - Normal Operation = Normal
- 1 - Abrupt Increase of BSW = AbrIncrBSW
- 2 - Spurious Closure of DHSV = SpurClosDHSW
- 3 - Severe Slugging = SevSlug
- 4 - Flow Instability = FlowInst
- 5 - Rapid Productivity Loss = RProdLoss
- 6 - Quick Restriction in PCK = QuiRestrPCK
- 7 - Scaling in PCK = ScalingPCK
- 8 - Hydrate in Production Line = HydrProdLine

In order to maintain the realistic aspects of the data, the dataset was built without preprocessing, including the presence of NaN values, frozen variables due to sensor or communication issues, instances with varying sizes, and outliers (R.E.V. Vargas, et al. 2019).

A concise summary of this data set generated by *pandas.DataFrame.info* method can be seen on Table 1.

2.2 Exploratory Data Analysis

EDA here

Column	pandas.Dtype
timestamp	datetime64[ns]
label	int64
well	object
id	int64
P-PDG	float64
P-TPT	float64
T-TPT	float64
P-MON-CKP	float64
T-JUS-CKP	float64
P-JUS-CKGL	float64
T-JUS-CKGL	float64
QGL	float64
class	float64
source	object

Table 1: Summary of the data set compiled from real instances

Figure 1: This frog was uploaded via the file-tree menu.

3 Data Preparation

Simply use the section and subsection commands, as in this example document! With Overleaf, all the formatting and numbering is handled automatically according to the template you've chosen. If you're using Rich Text mode, you can also create new section and subsections via the buttons in the editor toolbar.

First you have to upload the image file from your computer using the upload link in the file-tree menu. Then use the includegraphics command to include it in your document. Use the figure environment and the caption command to add a number and a caption to your figure. See the code for Figure 1 in this section for an example.

Note that your figure will automatically be placed in the most appropriate place for it, given the surrounding text and taking into account other figures or tables that may be close by. You can find out more about adding images to your documents in this help article on including images on Overleaf.

4 Modeling

Modeling here

5 Evaluation

Evaluation here

6 Conclusion

6.1 How to add Comments and Track Changes

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6.2 How to add Lists

You can make lists with automatic numbering ...

1. Like this,
2. and like this.

... or bullet points ...

- Like this,
- and like this.

6.3 How to write Mathematics

LaTeX is great at typesetting mathematics. Let $X_1, X_2, \ldots, X_n$ be a sequence of independent and identically distributed random variables with $\mathrm{E}[X_i] = \mu$ and $\mathrm{Var}[X_i] = \sigma^2 < \infty$, and let

$$S_n = \frac{X_1 + X_2 + \cdots + X_n}{n} = \frac{1}{n}\sum_{i}^{n} X_i$$

denote their mean. Then as n approaches infinity, the random variables $\sqrt{n}(S_n - \mu)$ converge in distribution to a normal $\mathcal{N}(0, \sigma^2)$.

6.4 How to change the margins and paper size

Usually the template you're using will have the page margins and paper size set correctly for that use-case. For example, if you're using a journal article template provided by the journal publisher, that template will be formatted according to their requirements. In these cases, it's best not to alter the margins directly.

If however you're using a more general template, such as this one, and would like to alter the margins, a common way to do so is via the geometry package. You can find the geometry package loaded in the preamble at the top of this example file, and if you'd like to learn more about how to adjust the settings, please visit this help article on page size and margins.

6.5 How to change the document language and spell check settings

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To change the spell check language, simply open the Overleaf menu at the top left of the editor window, scroll down to the spell check setting, and adjust accordingly.

6.6 How to add Citations and a References List

You can simply upload a `.bib` file containing your BibTeX entries, created with a tool such as JabRef. You can then cite entries from it, like this: [Gre93]. Just remember to specify a bibliography style, as well as the filename of the `.bib`. You can find a video tutorial here to learn more about BibTeX.

If you have an upgraded account, you can also import your Mendeley or Zotero library directly as a `.bib` file, via the upload menu in the file-tree.

6.7 Good luck!

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References

[Gre93] George D. Greenwade. The Comprehensive Tex Archive Network (CTAN). *TUGBoat*, 14(3):342–351, 1993.