Machine Learning Methods for Modeling and Classification of fashion MNIST

A Preprint

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Abstract

Fashion MNIST is a clothing classification dataset that is popular for deep learning and computer vision applications. In this report, we use Fashion MNIST to apply multiple machine learning methods reviewed in Data622: Machine Learning and Big Data, an elective course for the Masters of Science in Data Science at CUNY School of Professional Studies. We explore approaches to reduce the dimensionality of the data by engineering new descriptive features and performing Principal Components Analysis. We then follow this up with machine learning methods for classification such as Support Vector Machine and a Convolutional Neural Network. We find that

***K*eywords** fashion MNIST · machine learning · classification

1 Introduction

Fashion MNIST is a clothing classification dataset that builds in complexity in comparison to the classic MNIST dataset. MNIST is a dataset of handwritten digits that has been a go-to dataset for benchmarking various image processing and machine learning algorithms (LeCun et al. 1998). Classification algorithms applied to MNIST revolutionized the field of image processing in the 90s (**krizhevsky2009learning?**). However, contemporary machine learning methods can achieve 97% accuracy. Convolutional neural nets score as high as 99.7% accurate. As a result, MNIST is now considered too easy and has also been used thoroughly. Fashion MNIST was developed as an alternative.

Fashion MNIST can serve as a direct drop-in replacement for MNIST. Fashion MNIST and MNIST are both labeled data that share the same dataset size: 60,000 training images and 10,000 test images. Additionally,

Fashion MNIST and MNIST images share the same dimensions and structure: 10 distinct categories of grayscale images with 28x28 pixel size. Due to the complexity and variety of the images, Fashion MNIST is a more challenginf dataset for machine learning algorithms (Xiao, Rasul, and Vollgraf 2017).

In your report, be sure to:

- describe the problem you are trying to solve.
- describe your datasets and what you did to prepare the data for analysis.
- methodologies you used for analyzing the data
- why you did what you did
- make your conclusions from your analysis. Please be sure to address the business impact (it could be of any domain) of your solution.

2 Headings: first level

You can use directly LaTeX command or Markdown text.

LaTeX command can be used to reference other section. See Section 2. However, you can also use **bookdown** extensions mechanism for this.

2.1 Headings: second level

You can use equation in blocks

$$\xi_{ij}(t) = P(x_t = i, x_{t+1} = j|y, v, w; \theta) = \frac{\alpha_i(t) a_{ij}^{w_t} \beta_j(t+1) b_j^{v_{t+1}}(y_{t+1})}{\sum_{i=1}^{N} \sum_{j=1}^{N} \alpha_i(t) a_{ij}^{w_t} \beta_j(t+1) b_j^{v_{t+1}}(y_{t+1})}$$

But also inline i.e $z = x + y$

2.1.1 Headings: third level

Another paragraph.

3 Examples of citations, figures, tables, references

You can insert references. Here is some text (Kour and Saabne 2014b, 2014a) and see Hadash et al. (2018).

The documentation for `natbib` may be found at

You can use custom blocks with LaTeX support from **rmarkdown** to create environment.

`http://mirrors.ctan.org/macros/latex/contrib/natbib/natnotes.pdf%7D`

Of note is the command `\citet`, which produces citations appropriate for use in inline text.

You can insert LaTeX environment directly too.

```
\citet{hasselmo} investigated\dots
```

produces

> Hasselmo, et al. (1995) investigated...

`https://www.ctan.org/pkg/booktabs`

3.1 Figures

You can insert figure using LaTeX directly.

See Figure 1. Here is how you add footnotes. [^Sample of the first footnote.]

But you can also do that using R.

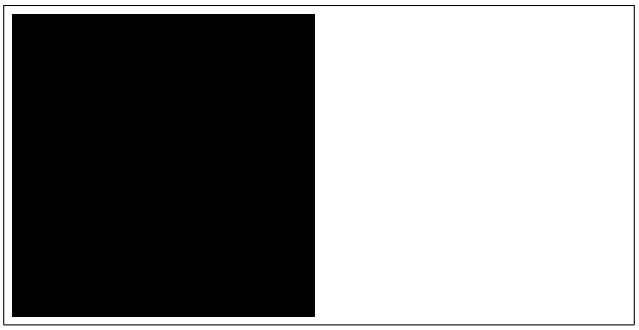

Figure 1: Sample figure caption.

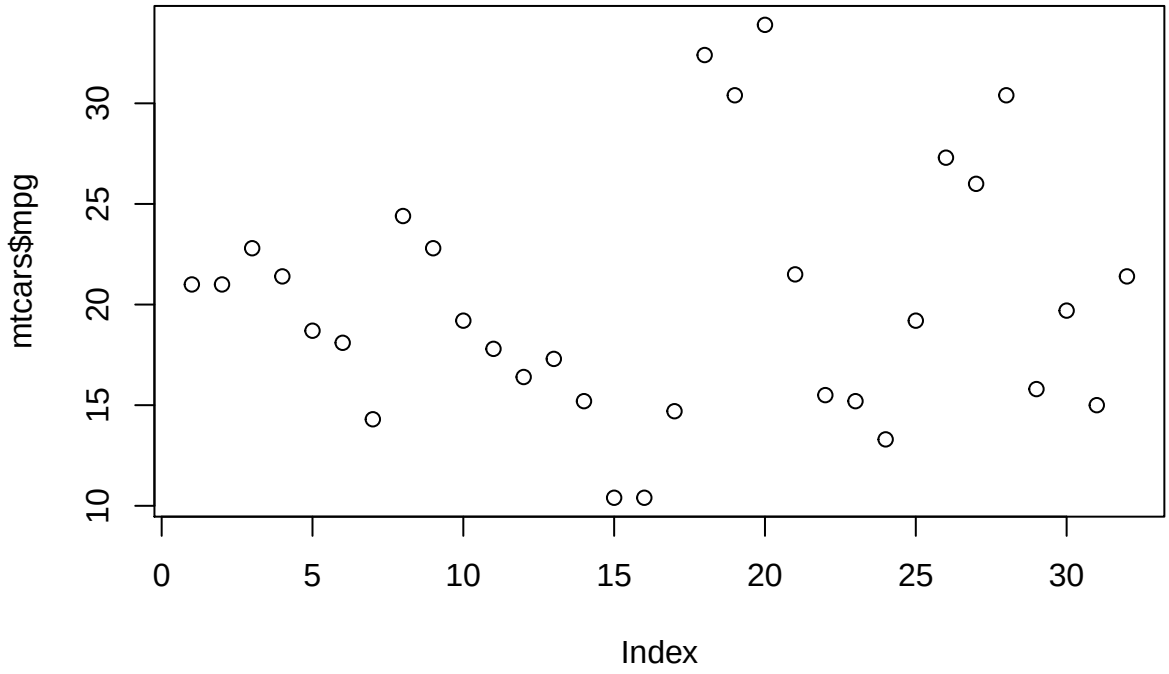

Figure 2: Another sample figure

```
plot(mtcars$mpg)
```

You can use **bookdown** to allow references for Tables and Figures.

3.2 Tables

Below we can see how to use tables.

See awesome Table~1 which is written directly in LaTeX in source Rmd file.

You can also use R code for that.

Table 1: Sample table title

Part		
Name	Description	Size (μm)
Dendrite	Input terminal	$\sim$100
Axon	Output terminal	$\sim$10
Soma	Cell body	up to 10^6

```
knitr::kable(head(mtcars), caption = "Head of mtcars table")
```

Table 2: Head of mtcars table

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
Mazda RX4	21.0	6	160	110	3.90	2.620	16.46	0	1	4	4
Mazda RX4 Wag	21.0	6	160	110	3.90	2.875	17.02	0	1	4	4
Datsun 710	22.8	4	108	93	3.85	2.320	18.61	1	1	4	1
Hornet 4 Drive	21.4	6	258	110	3.08	3.215	19.44	1	0	3	1
Hornet Sportabout	18.7	8	360	175	3.15	3.440	17.02	0	0	3	2
Valiant	18.1	6	225	105	2.76	3.460	20.22	1	0	3	1

3.3 Lists

- Item 1
- Item 2
- Item 3

Hadash, Guy, Einat Kermany, Boaz Carmeli, Ofer Lavi, George Kour, and Alon Jacovi. 2018. "Estimate and Replace: A Novel Approach to Integrating Deep Neural Networks with Existing Applications." *arXiv Preprint arXiv:1804.09028*.

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LeCun, Yann, Léon Bottou, Yoshua Bengio, and Patrick Haffner. 1998. "Gradient-Based Learning Applied to Document Recognition." *Proceedings of the IEEE* 86 (11): 2278–2324.

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