# A TEMPLATE FOR THE *arxiv* STYLE

A PREPRINT

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**ABSTRACT**

Diabetic retinopathy is an eye disease that can affect people suffering diabetes. It causes damage to the blood vessels of the eyes, deteriorates the eyesight and can lead in the worst case to blindness of the patient. It is important to detect the disease in an early stage to mitigate it as good as possible with an early treatment. Analyzing images of eyes and classify the severity of diabetic retinopathy is a challenging task that requires expert knowledge. To assist doctors and medical personnel, a classification model shall be trained to classify the severity automatically.

## 1 Introduction

Text about why diabetic retinopathy Detection

Dataset

## 2 Object Classification

### 2.1 Problem analysis

Einordnung als supervised learning problem

To tackle the problem of diabetic retinopathy detection, several methods are possible. Because the dataset consists of ordinally scaled data of 5 classes, regression could be used to estimate the serverity of a case. In addition, a the problem can be handled as a classification problem after one-hot-encoding the labels. As a third option, one can define a threshold to define problematic diabetic retinopathy and non-problematic diabetic retinopathy and can handle the problem as a binary classification. Further, only binary and multiclass classification are anaylzed.

A binary classification has the advantage of higher accuracy, but lacks details, because the network only outputs 0 or 1 and no information about the exact serverity of the disease. Metrics are also easy to implement, because precision, recall and f1-score are standard implementations and nicely interpretable.

A multiclass classification has typically a lower accuracy, because the network needs to pick the right class among several classes. It provides the benefit or receiving richer information, i.e. the exact serverity of the disease. Evaluating a multiclass classification problem becomes harder, because missclassifications can vary in their error. Classifiying a class 1 as class 2 is for example less problematic than classifying class 1 as class 5.

### 2.2 Architecture

VGG, Resnet, Weight freeeze / unfreeze, GAP, Flatten, Dense Layers

[*]Use footnote for providing further information about author (webpage, alternative address)—*not* for acknowledging funding agencies.

### 2.3 Weight initialization

### 2.4 Augmentation

### 2.5 Dataset Balancing

### 2.6 Training

Adam, SGD, Momentum, Learing rate decay

### 2.7 Metrics

incl. QWC

## 3 Experiments

### 3.1 Procedure

The training of the deep neural network classifier requires the selection of suitable hyperparameters that differ from problem to problem. A useful strategy to find a good set of hyperparameters are parameter sweeps. Weights&Biases is a python library that enables the easy implementation of sweeps.

Hyperparameter optimization requires besides training and test dataset a third, the validation dataset, to evaluate the model after hyperparameter tuning and to avoid overfitting on the hyperparameters. Because the given dataset only contains training and test data, the original training dataset was split into 80% training data and 20% validation data.

In total, x sweeps consisting of x runs and x epochs were performed during the project.

### 3.2 Hyperparameter selection

The following parameters show a big effect on the performance of the neural network on the validation data, why they are selected for the final classifier.

Balancing

...

### 3.3 Grad cam

## 4 Results

best binary + multiclass performance; color coded confusion matrix

## 5 Headings: first level

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### 5.1 Headings: second level

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$$\xi_{ij}(t) = P(x_t = i, x_{t+1} = j | y, v, w; \theta) = \frac{\alpha_i(t) a^{w_t}_{ij} \beta_j(t+1) b^{v_{t+1}}_j (y_{t+1})}{\sum^N_{i=1} \sum^N_{j=1} \alpha_i(t) a^{w_t}_{ij} \beta_j(t+1) b^{v_{t+1}}_j (y_{t+1})} \tag{1}$$

#### 5.1.1 Headings: third level

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## 6 Examples of citations, figures, tables, references

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The documentation for `natbib` may be found at

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

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

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

produces

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

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

### 6.1 Figures

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### 6.2 Tables

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[2] Sample of the first footnote.

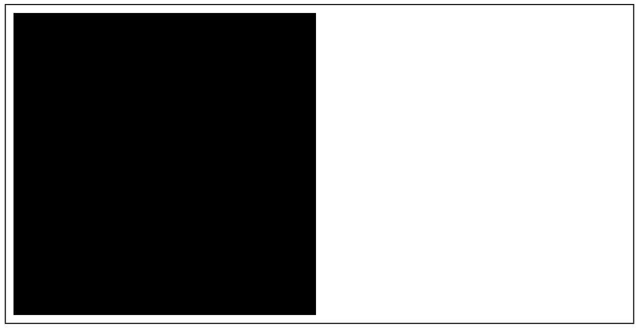

Figure 1: Sample figure caption.

Table 1: Sample table title

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

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### 6.3 Lists

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- consectetur adipiscing elit.
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## References

[1] George Kour and Raid Saabne. Real-time segmentation of on-line handwritten arabic script. In *Frontiers in Handwriting Recognition (ICFHR), 2014 14th International Conference on*, pages 417–422. IEEE, 2014.

[2] George Kour and Raid Saabne. Fast classification of handwritten on-line arabic characters. In *Soft Computing and Pattern Recognition (SoCPaR), 2014 6th International Conference of*, pages 312–318. IEEE, 2014.

[3] Guy Hadash, Einat Kermany, Boaz Carmeli, Ofer Lavi, George Kour, and Alon Jacovi. Estimate and replace: A novel approach to integrating deep neural networks with existing applications. *arXiv preprint arXiv:1804.09028*, 2018.