



L-Università ta' Malta
Faculty of Information &
Communication Technology

Department
of Artificial
Intelligence

ARI 2129 - Principles of Computer Vision

Group Project - Part A

Matthias Bartolo 0436103L *

Luke Cardona 0011803H *

Jerome Agius 0353803L *

Isaac Muscat 0265203L *

*B.Sc. (Hons) Artificial Intelligence (2nd Years)

Study-unit: **Principles of Computer Vision for AI**

Code: **ARI2129**

Lecturer: **Dr Dylan Seychell**

Q1: Writing a background about Data Augmentation

Introduction

Data Augmentation (DA) is a crucial component of **Computer Vision (CV)** due to its utility in reducing overfitting in Deep Learning. In most cases in the field of CV there is a lack of diversity in the training dataset, incurred by the work required to procure a reasonable number of distinct images [1,2]. DA solves this problem via the generation of more training samples through the use of techniques such as **Geometric transformations** and **Photometric distortions**, thus improving the generalisation of such deep learning models [3-5].

Historical Context

One of the first major breakthroughs in CV occurred between the 1980s and 1990s, where **Edge Detection** algorithms were constructed and implemented into industrial automation [6]. Additionally, in 2012, **Object Recognition** made a significant leap forward with the introduction of **ImageNet**, an extensive and labelled dataset that aided training classification models [7]. At the same time, **CNNs** were inaugurated to image classification in collaboration with ILSVRC Models which provided notable progression over prior approaches [8]. Moreover, in 2015 the **COCO** dataset was launched, where images were assigned multiple labels to assist in precise **Contextual Classification** of noisy images [4].

Data Augmentation Techniques

As previously mentioned, there are two main types of DA techniques, **Geometric transformations** and **Photometric distortions**:

Geometric transformations

Geometric techniques focus on changing images to different sizes, positions, and rotations, making trained models more robust due to the diversity found in objects with different geometric properties. **Rotations** geometrically transform an image on a singular central point by an angle on the z-axis. **Flipping** is a 180-degree rotation on either the x or y axis. **Scaling** resizes an image by adjusting its size with regards to its original proportions, without any change in shape or orientation. **Cropping** trims or resizes the outer borders of the image, starting from an edge. **Translation** moves the image's pixel positions from one point to another without changing its size or rotation. Finally, **Shearing** concerns moving pixels along an axis by a specified amount, distorting the image.

Photometric distortions

Photometric techniques focus on **Colour Jittering**, consisting of altering the brightness, contrast, and saturation of the image. Moreover, they also involve shifting the values in each colour channel and adding gaussian noise. This helps improve the model's robustness to deal with different image lighting and quality. Altering **Brightness** refers to adjusting the gamma channel of an image. **Contrast** is defined as the change in colour and tones, or the ratio between lighter and darker sections within an image [9]. **Saturation** involves proportionally adjusting the colour channel values in an image. Furthermore, it is also possible to adjust the values of one specific colour channel, for instance increasing the green channel's value. Finally, **Gaussian Noise** blurs the image in proportion to the distance from the centre point, thus achieving a greater blur the farther away it is from the centre point [5].

Recent Advancements

Multiple major advancements in CV have recently occurred, such as **Cutout** [10]. This technique involves randomly masking out regions of an image during training. This method can be easily implemented alongside other techniques to improve performance of **CNNs** [10]. By forcing the **CNN** to learn from incomplete data it is encouraged to consider all relevant features of the image. In comparison, **MixUp** [11] multiplies two images and superimposes them depending on various coefficient ratios, substituting labels accordingly. This encourages the model to learn smooth decision boundaries between classes. **AutoAugment** [12] searches for the most effective augmentation policy for a dataset by means of reinforcement learning methods to avoid overfitting. Thus, it produces the most accurate deep learning model.

Applications in Computer Vision

Common DA methods [5,9,13] can assist in solving the major problem of **image shortage** when it comes to developing CV models. Furthermore, combining these methods with more recent DA methods [11,14-16] is **reducing costs and time** of data collection [1,2]. Such techniques can also supply images when there is a shortage of images in an already existing dataset [17].

Generative Adversarial Networks (GANs) have been used to allow the creation of new images to train classification models to represent situations not present in the current dataset [18,19]. Furthermore, GAN's have been used to generate new labelled medical images without incurring the heavy costs of having to label large amounts of medical images [20-22]. Additionally, these are also used in the creation of autonomous vehicles [23].

A prime example of applications of DA techniques can be seen in the **YoloV4** [24] model which makes use of various augmentation techniques related to object detection and segmentation such as **CutOut** [10], **MixUp** [11] and **CutMix** [14]. These techniques are also used to aid the accuracy of deep learning models and reduce overfitting [25-28].

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Q2: Using ChatGPT as a writing assistant.

Prompt 1

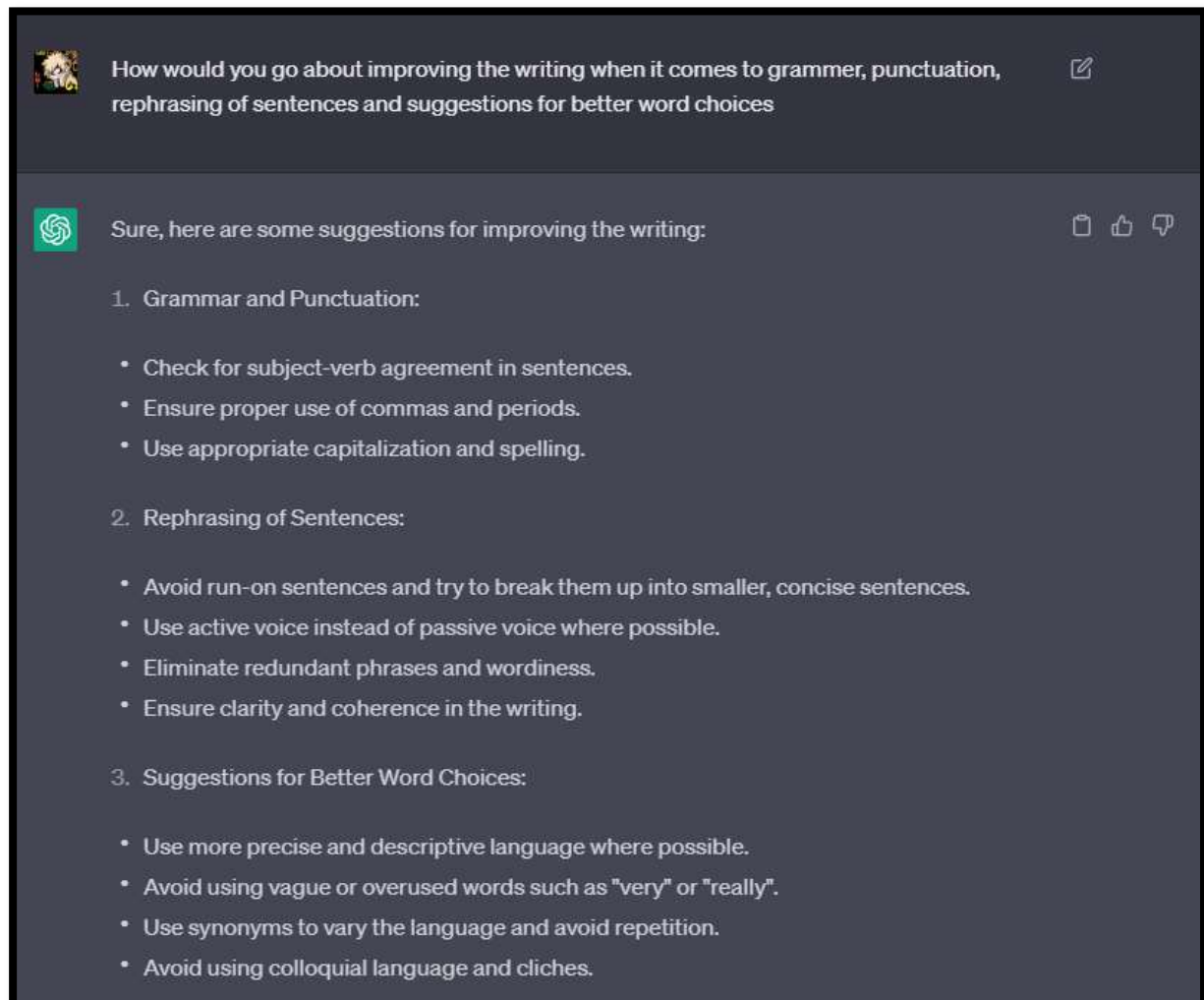


Figure 1: Prompt 1(1/2)

Here are some examples of how these suggestions could be applied to improve the original text:

Original: In most cases in the field of CV there is a lack of diversity in the training dataset, incurred by the work required to procure a reasonable number of distinct images.

Revised: In many cases within the field of CV, training datasets lack diversity due to the challenges involved in acquiring a sufficient number of unique images.

Original: Additionally, in 2012, Object Recognition made a significant leap forward with the introduction of ImageNet, an extensive and labelled dataset that aided training classification models [7].

Revised: Object recognition took a major leap forward in 2012 with the launch of ImageNet, a comprehensive and labeled dataset that greatly facilitated the training of classification models.

Original: Common DA methods [5,9,13] can assist in solving the major problem of image shortage when it comes to developing CV models.

Revised: Utilizing common DA methods [5,9,13] can help address the significant challenge of limited image availability in the development of CV models.

Overall, by implementing these suggestions, the writing can be improved for clarity, coherence, and precision.

Figure 2: Prompt 1 (2/2)

Prompt 2

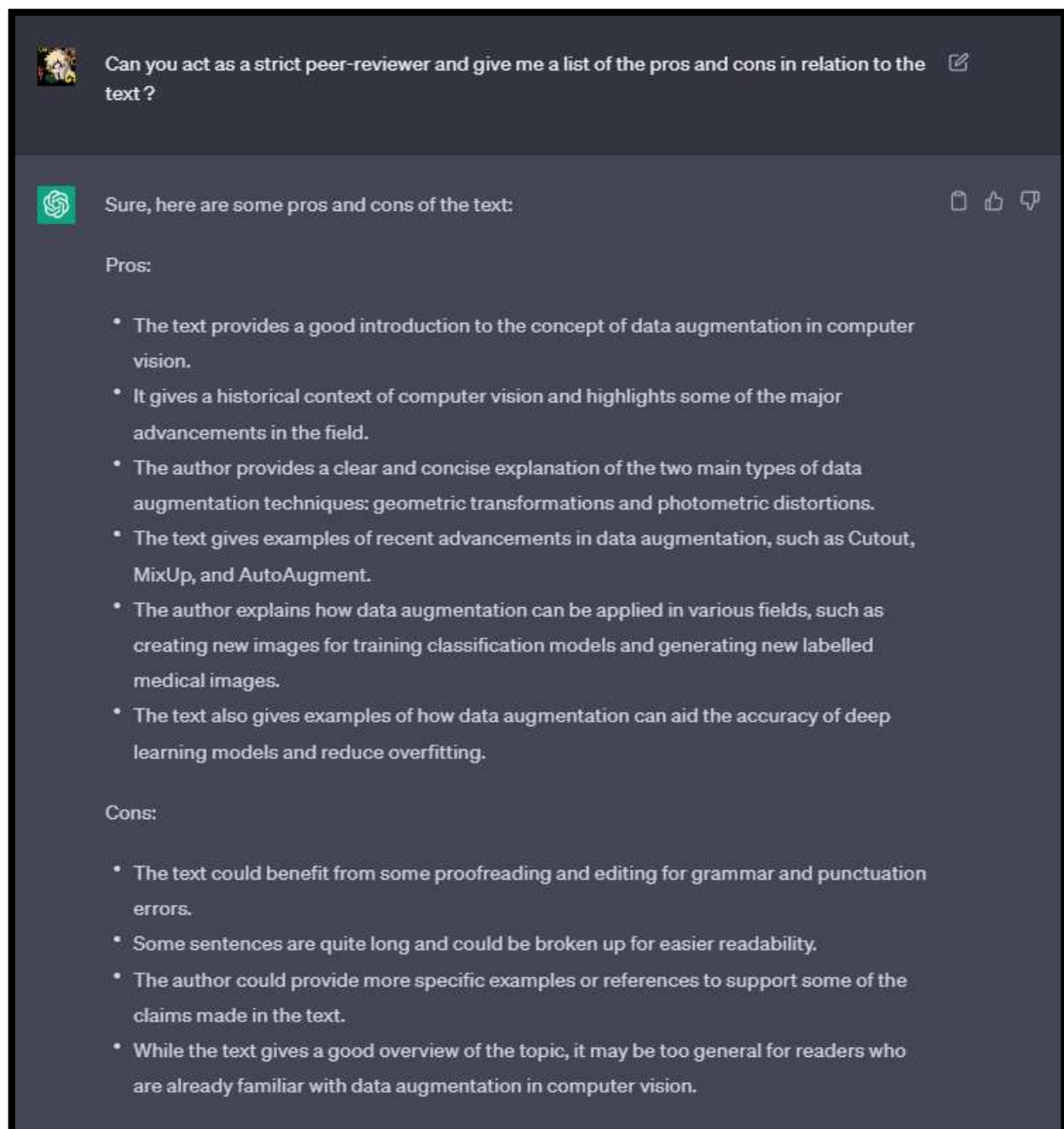
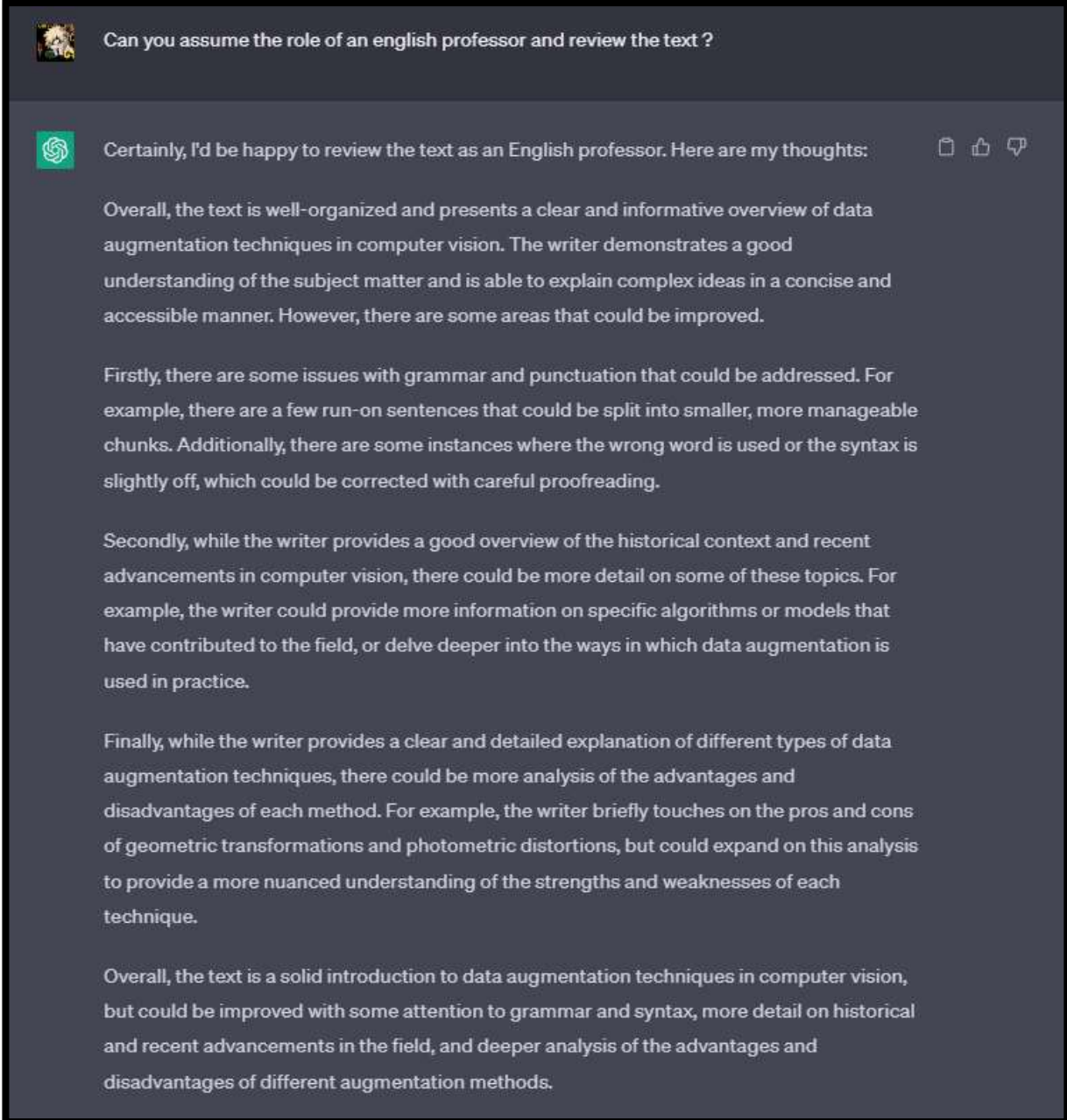


Figure 3: Prompt 2

Prompt 3



The screenshot shows a chat interface with a dark background. At the top, a user prompt is displayed in a lighter grey box. Below it, the AI response is shown in a dark grey box with a green OpenAI logo icon on the left. The response consists of several paragraphs of text. At the top right of the response box, there are three small icons: a document, a thumbs up, and a thumbs down.

User Prompt: Can you assume the role of an english professor and review the text ?

AI Response:

Certainly, I'd be happy to review the text as an English professor. Here are my thoughts:

Overall, the text is well-organized and presents a clear and informative overview of data augmentation techniques in computer vision. The writer demonstrates a good understanding of the subject matter and is able to explain complex ideas in a concise and accessible manner. However, there are some areas that could be improved.

Firstly, there are some issues with grammar and punctuation that could be addressed. For example, there are a few run-on sentences that could be split into smaller, more manageable chunks. Additionally, there are some instances where the wrong word is used or the syntax is slightly off, which could be corrected with careful proofreading.

Secondly, while the writer provides a good overview of the historical context and recent advancements in computer vision, there could be more detail on some of these topics. For example, the writer could provide more information on specific algorithms or models that have contributed to the field, or delve deeper into the ways in which data augmentation is used in practice.

Finally, while the writer provides a clear and detailed explanation of different types of data augmentation techniques, there could be more analysis of the advantages and disadvantages of each method. For example, the writer briefly touches on the pros and cons of geometric transformations and photometric distortions, but could expand on this analysis to provide a more nuanced understanding of the strengths and weaknesses of each technique.

Overall, the text is a solid introduction to data augmentation techniques in computer vision, but could be improved with some attention to grammar and syntax, more detail on historical and recent advancements in the field, and deeper analysis of the advantages and disadvantages of different augmentation methods.

Figure 4: Prompt 3

Prompt 4

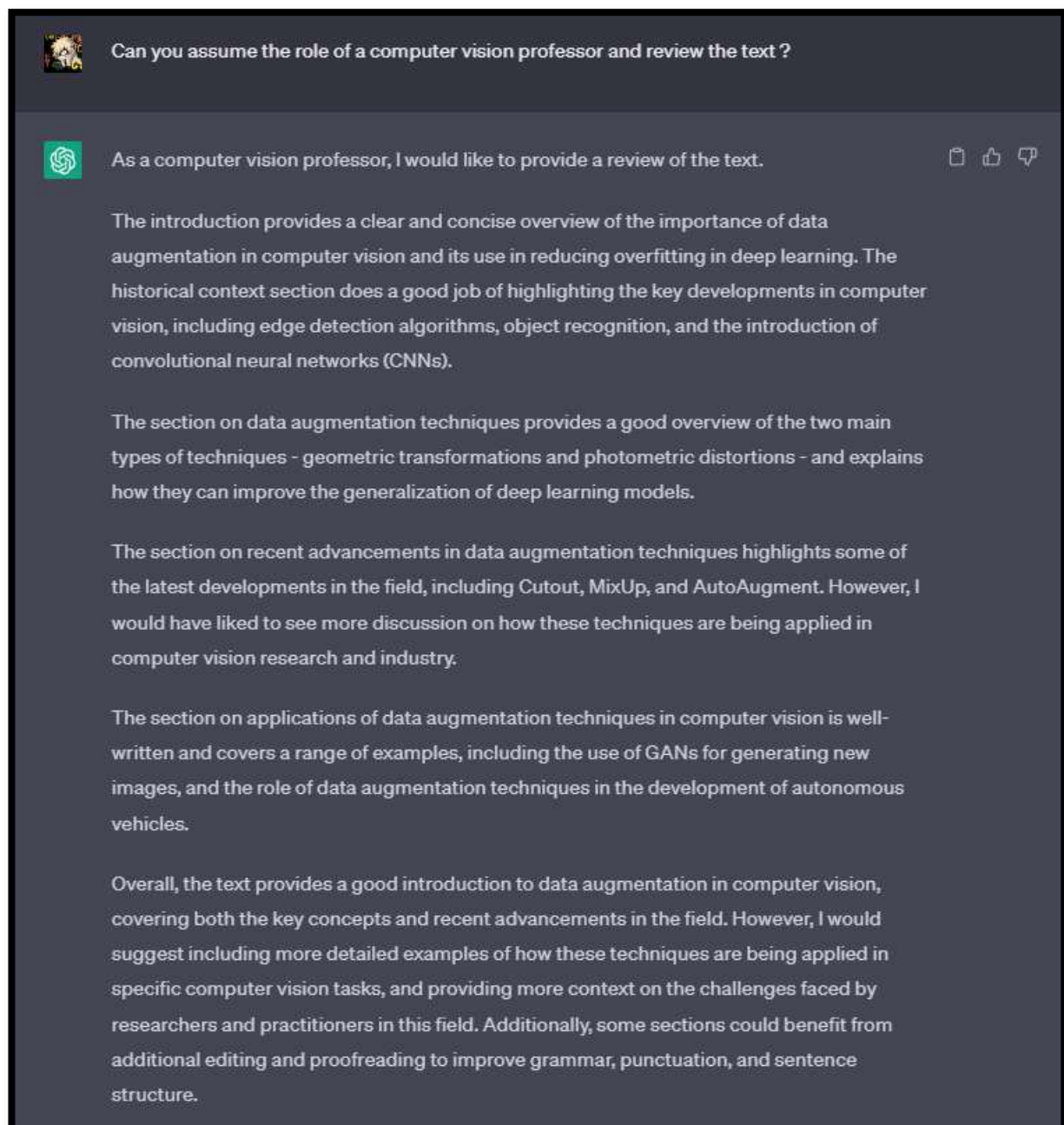
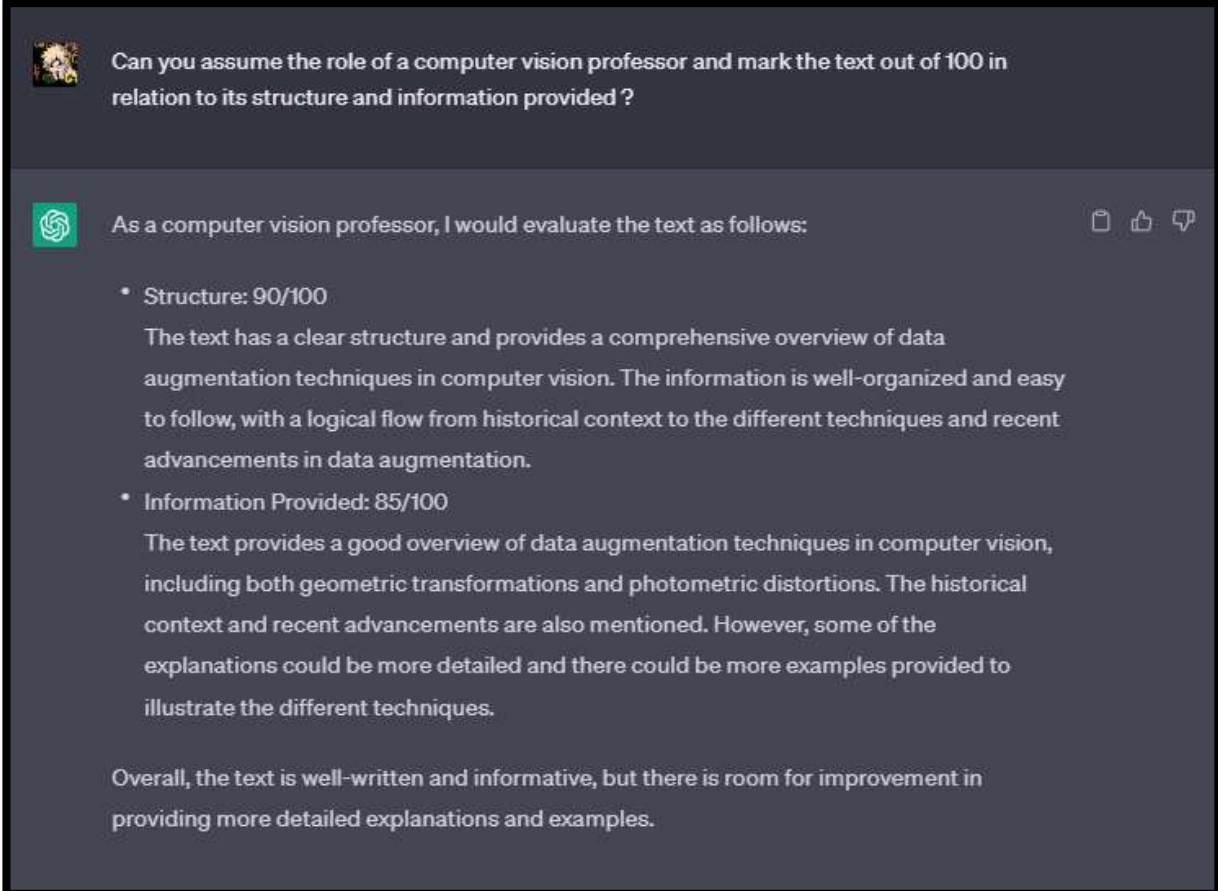


Figure 5: Prompt 4

Prompt 5



The screenshot shows a chat interface with a dark background. At the top, a user prompt is displayed next to a small profile picture. The response from the AI, identified by a green logo, is shown below. The response includes a structured evaluation of a text, with bullet points for 'Structure' and 'Information Provided', each followed by a paragraph of analysis. At the bottom, a summary paragraph is provided. On the right side of the response, there are three small icons: a document, a thumbs up, and a speech bubble.

Can you assume the role of a computer vision professor and mark the text out of 100 in relation to its structure and information provided ?

As a computer vision professor, I would evaluate the text as follows:

- **Structure: 90/100**
The text has a clear structure and provides a comprehensive overview of data augmentation techniques in computer vision. The information is well-organized and easy to follow, with a logical flow from historical context to the different techniques and recent advancements in data augmentation.
- **Information Provided: 85/100**
The text provides a good overview of data augmentation techniques in computer vision, including both geometric transformations and photometric distortions. The historical context and recent advancements are also mentioned. However, some of the explanations could be more detailed and there could be more examples provided to illustrate the different techniques.

Overall, the text is well-written and informative, but there is room for improvement in providing more detailed explanations and examples.

Figure 6: Prompt 5

Prompt 6

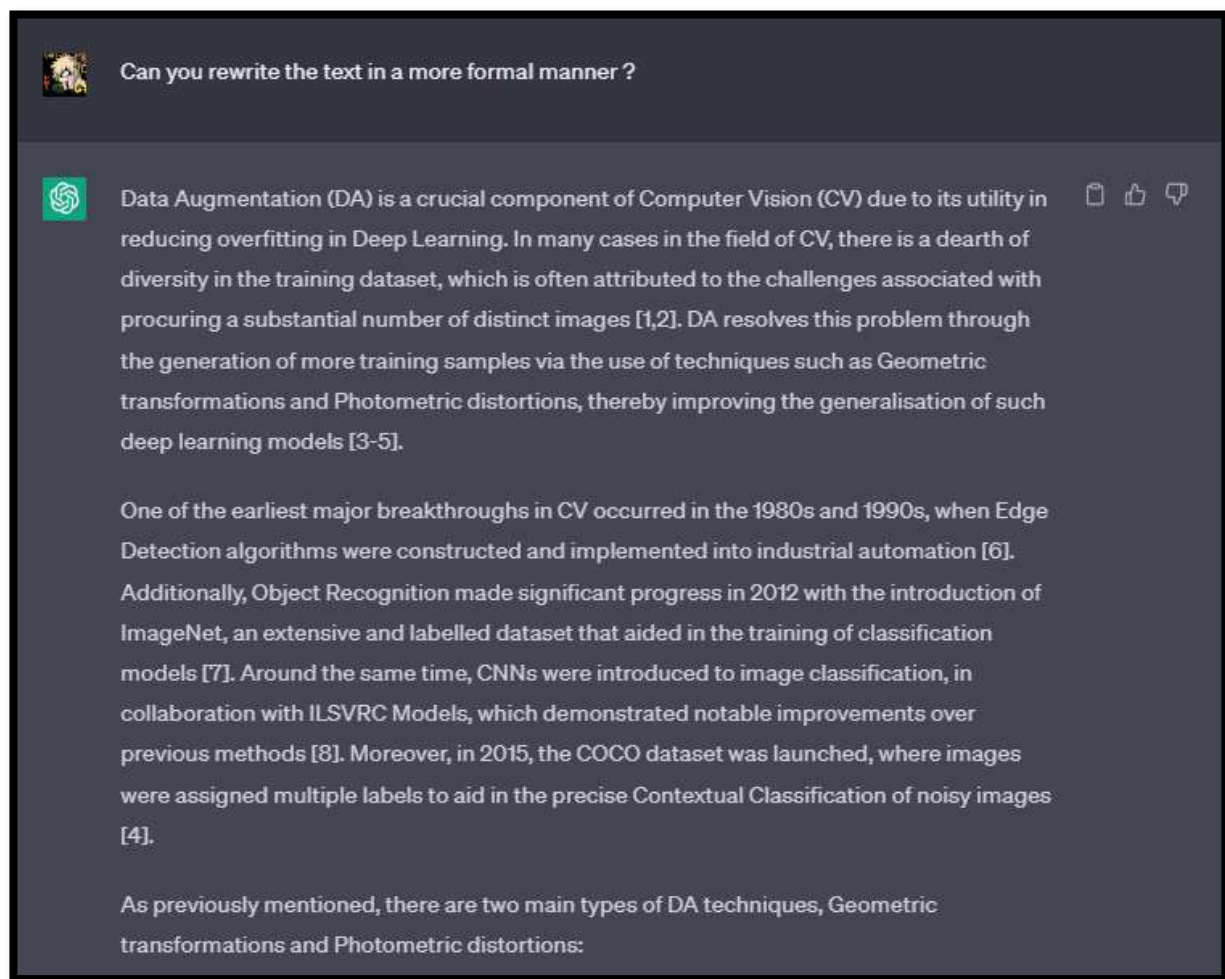


Figure 7: Prompt 6 (1/3)

Geometric transformations

Geometric techniques focus on changing images to different sizes, positions, and rotations, making trained models more robust due to the diversity found in objects with different geometric properties. Rotations geometrically transform an image on a singular central point by an angle on the z-axis. Flipping is a 180-degree rotation on either the x or y axis. Scaling resizes an image by adjusting its size with regards to its original proportions, without any change in shape or orientation. Cropping trims or resizes the outer borders of the image, starting from an edge. Translation moves the image's pixel positions from one point to another without changing its size or rotation. Finally, Shearing involves moving pixels along an axis by a specified amount, distorting the image.

Figure 9: Prompt 6 (2/3)

Photometric distortions

Photometric techniques focus on Colour Jittering, consisting of altering the brightness, contrast, and saturation of the image, furthermore, shifting the values in each colour channel and adding gaussian noise. This helps improve the model's robustness to deal with different image lighting and quality. Altering Brightness refers to adjusting the gamma channel of an image. Contrast is defined as the change in colour and tones, or the ratio between lighter and darker sections within an image [9]. Saturation involves proportionally adjusting the colour channel values in an image. Furthermore, it is also possible to adjust the values of one specific colour channel, for instance increasing the green channel's value. Finally, Gaussian Noise blurs the image in proportion to the distance from the centre point, thus achieving a greater blur the farther away it is from the centre point [5].

Multiple major advancements in CV have recently occurred, such as Cutout [10]. This technique involves randomly masking out regions of an image during training. This method can be easily implemented alongside other techniques to improve the performance of CNNs [10]. In comparison, MixUp [11] multiplies two images and superimposes them depending on various coefficient ratios, substituting labels accordingly. AutoAugment [12] searches for the most effective augmentation policy for a dataset, by means of reinforcement learning methods, to produce the most accurate deep learning model.

Common DA methods [5,9,13] can assist in solving the major problem of image shortage when it comes to developing CV models. Furthermore, combining these methods with more recent DA methods [11,14-16] is reducing costs and time of data collection [1,2

Figure 8: Prompt 6 (3/3)

Reflections

Matthias

Throughout the various interactions and prompts with ChatGPT, it was interesting to notice how this software took on different roles while suggesting different improvements. A key observation was that the "English professor scenario" led to more grammatical and structural errors being highlighted, whereas the "Computer Vision professor scenario" resulted in more technical errors being highlighted. I also found ChatGPT's rating of my work on a scale of 100 to be a very helpful prompt for accurately assessing the calibre of my performance. Nevertheless, some of the ChatGPT feedback was unusable, as it dictated delving into various areas of study, a task that would have exceeded the prescribed limited word count. The ability of ChatGPT to rewrite text, on the other hand, also piqued my interest because it can be helpful in laying out various textual structures and conceptual frameworks.

Luke

In regards to the ChatGPT conversations, it clearly identified possible improvements by highlighting missing topics or areas where more emphasis was required. When assuming different roles, ChatGPT offered different perspectives and feedback on the text, aiding in separating grammatical and technical feedback and allowing ChatGPT to go further in depth with the critiques. The critiques offered on English writing were possible weaknesses present in my current writing, which I will keep in mind for future writing. Most of the recommendations offered, however, were focused around adding information, which was not possible due to the 600-word limit. Potentially, we could have been more concise and avoided minor repetitions throughout the text. Nevertheless, ChatGPT was a helpful gauge for assessing our own work, allowing for immediate, easy to digest feedback and improvements.

Jerome

The use of ChatGPT proved to be a useful tool in determining areas where our text needed improvement, as can be seen in Figures 1-3. However, the effectiveness of ChatGPT varied in accordance with the persona that it assumed. In the "English professor scenario" (Figure 4) ChatGPT gave greater importance to grammatical and structural errors whereas in the "computer vision professor scenario" (Figure 5) more technical errors were pointed out. This showcases that by customising the prompts given to ChatGPT a more tailored response can be provided to the user. In continuation, ChatGPT can also rewrite text as can be seen in Figures 2 and 7-9 which can prove useful in outlining different ways in which text can be structured and ideas outlined. Finally, as seen in Figure 6, ChatGPT can provide a numerical score in relation to the text which can prove useful in conceptualising the quality of the text overall. Overall, ChatGPT proves to be a valuable tool in aiding students/researchers to produce work which has a greater degree of cohesion but is also accurate in the information provided.

Isaac

To evaluate our work, we prompted ChatGPT to assume two different roles and to review our work. When given the English Professor role, ChatGPT provided guidelines on how to strengthen the structure of our text such as utilising punctuation appropriately and phrasing sentences in a more legible manner. However, it also highlighted issues which could not be solved due to the word limit such as adding information about the limitations of Data Augmentation techniques, which was not required in this assignment. When given the Computer Vision professor role, ChatGPT offered insights on which sections of the text could be improved to explain Data Augmentation better. Additionally, we also queried ChatGPT to assign an overall mark to our work. This helped us obtain an idea of the quality of our work if it had to be reviewed by a Computer Vision professor. Furthermore, when queried, ChatGPT was also able to rewrite the entire text in a more formalised manner, further showing how powerful ChatGPT can be when generating a response suitable for the user. To conclude, this section of the assignment helped me understand how to prompt ChatGPT to review and correct my work in multiple ways.

Plagiarism Declaration Form:

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

Declaration

Plagiarism is defined as "the unacknowledged use, as one's own work, of work of another person, whether or not such work has been published" (Regulations Governing Conduct at Examinations, 1997, Regulation 1 (viii), University of Malta).

+/ We*, the undersigned, declare that the [assignment / Assigned Practical Task report / Final Year Project report] submitted is ~~not~~ our* work, except where acknowledged and referenced.

+ / We* understand that the penalties for making a false declaration may include, but are not limited to, loss of marks; cancellation of examination results; enforced suspension of studies; or expulsion from the degree programme.

Work submitted without this signed declaration will not be corrected, and will be given zero marks.

* Delete as appropriate.

(N.B. If the assignment is meant to be submitted anonymously, please sign this form and submit it to the Departmental Officer separately from the assignment).


Matthias Bartolo
Student Name


Signature

Jerome Agius
Student Name


Signature

Luke Cardona
Student Name


Signature

Isaac Muscat
Student Name


Signature

ARI2129
Course Code

Principles of Computer Vision for AI Assignment (Part A)
Title of work submitted

23/04/2023
Date