

Computer Vision

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Computer Vision, CA2

DL836 BSc (Hons) in Creative Computing

Year 4, Term 2

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# Acknowledgments

The author would like to thank the reviewer John Dempsey, Faculty of Computer Science, (Creative Computing), Institute of Art, Design & Technology, for very useful comments and suggestions.

He would also like to thank his colleagues in work who are and are not, part of the MTC team.  
  
Ireland, Dublin   
Conor P. Weldon January 2023

# Introduction

How can a machine, imitate a human? How can we create a brain from lines and codes? How can a machine, gain experiences, learn, adapt, and evolve? These questions are those in which I plan to discuss today, in hopes of giving you an understanding into the process behind this “brain”. Without a doubt, the most outstanding question is: “When can we say that a system constructed by a human designer is intelligent?”, this is a key problem in the AI field today.

However, I plan to talk about a specific area, **Computer Vision.** One could say computer vision is the ability to give our machines eyes. It unlocks one of our 5 senses, further developing our “computer brain”. It is the process in which a machine can analyse, acknowledge and insight into both Images or Videos. This is all possible with the improvement of algorithms in regard to Machine Learning in the past decade.

## Keywords:

artificial intelligence, computer vision, azure, API, facial recognition, emotional recognition, neural networks, data mining, algorithms, probability, data sets, Image Recognition.

# Understand computer vision

Visual processing is the focus of the branch of AI known as computer vision. Let's examine a few of the potential applications of computer vision.

A fantastic illustration of the capabilities of computer vision is the Seeing AI app. The Seeing AI software, created for the blind and low vision users, uses artificial intelligence to describe surrounding people, text, and objects and to open up the visual world.

## Computer Vision models and capabilities

Machine learning models, which may be used to process sensory information from cameras, movies, or photos, are the foundation of the majority of computer vision solutions. Traditional computer vision tasks are outlined in the table below.

| **Task** | **Description** |
| --- | --- |
| Image classification | An image of a taxi with the label "Taxi"  In order to categorize photos premised on their properties, a machine learning model must be trained. For instance, you could employ an image classification model in some kind of a traffic surveillance system to categorize photographs depending on the kinds of vehicles they show, which including taxis, buses, bicycles, and so forth. |
| Object detection | An image of a street with buses, cars, and cyclists identified and highlighted with a bounding box  Machine learning models for object recognition are taught to categorize specific items inside an image and pinpoint their exact locations using bounding boxes. For instance, a traffic monitoring system may employ object detection to locate various automobile classifications. |
| Semantic segmentation | An image of a street with the pixels belonging to buses, cars, and cyclists identified  A sophisticated ML approach called semantic segmentation allows for the classification of distinct picture pixels in accordance with the item with which they correspond. To emphasize distinct cars using certain colours, a traffic surveillance system, for instance, can overlay traffic photos with "mask" layers. |
| Image analysis | An image of a person with a dog on a street and the caption "A person with a dog on a street"  To retrieve data from photos, such as "tags" that might assist classifying the picture or even provide meaningful comments that briefly describe the scenario depicted in the picture, developers can develop systems that incorporate both machine learning models with sophisticated image analysis techniques. |
| Face detection, analysis, and recognition | An image of multiple people on a city street with their faces highlighted  Finding a person or peoples faces in a picture is done using a particular kind of object detection called face detection. This may be used in conjunction with facial geometry analysis as well as segmentation methods to identify people according to their face traits. |
| Optical character recognition (OCR) | An image of a building with the sign "Toronto Dominion Bank", which is highlighted  To find and understand text in photographs, a technique called optical character recognition is utilized. OCR may be utilized to retrieve data from scanned documents like emails, bills, and forms as well as to scan text from images of things like business fronts or road signage. |

## Computer vision services in Microsoft Azure

Microsoft Azure provides the following cognitive services to help you create computer vision solutions:

| **Service** | **Capabilities** |
| --- | --- |
| **Computer Vision** | With the help of this service, you may analyse photographs and videos and retrieve text, "tags", objects, and summaries from them. |
| **Custom Vision** | Utilize this tool to educate personalized object recognition and picture classification models by utilizing your own photographs. |
| **Face** | You may create face detection and facial recognition applications using the Face service. |
| **Form Recognizer** | Utilize this service to get data out of scanned documents and invoices.. |

# 

# Azure Face API

Azure Face API is a cloud-based service provided by Microsoft that allows developers to add facial recognition and analysis capabilities to their applications. This service can detect faces in images and videos, identify individuals, and analyse facial features such as age, gender, and emotion.

## Features of Azure Face API

One key feature of Azure Face API is its ability to detect and recognize faces in images and videos with high accuracy. This is achieved through the use of deep learning algorithms, which are trained on a large dataset of faces to learn the unique characteristics of different individuals. Once a face is detected, the service can then compare it to a database of known faces to identify the individual.

Another important feature of Azure Face API is its ability to analyse facial features such as age, gender, and emotion. This can be useful for a wide range of applications, including security systems, human-computer interaction, and marketing research. For example, a retail store could use this technology to track customer demographics and preferences, or a security system could use it to identify individuals who are on a watchlist.

Azure Face API also offers a number of security and privacy features to help ensure the protection of personal data. These include support for Azure Active Directory for authentication and authorization, as well as the ability to store data in a private, isolated environment using Azure Virtual Networks.

## Azure Face API Conclusion

Overall, Azure Face API is a powerful and versatile tool for adding facial recognition and analysis capabilities to applications. It is suitable for a wide range of use cases, from security and surveillance to marketing and research.

# Introduction to Facial Recognition

Facial recognition technology has come a long way in recent years, and it is now being used in a wide range of applications, from security and surveillance to marketing and research. One key application of facial recognition technology is in the form of facial recognition scanners, which are used to identify individuals by analysing their facial features. In this report, we will take a closer look at the technology behind facial recognition scanners, as well as their potential uses and limitations.

## How Facial Recognition Scanners Work

Facial recognition scanners rely on the use of deep learning algorithms, which are trained on a large dataset of faces to learn the unique characteristics of different individuals. Once a face is detected, the scanner compares it to a database of known faces to identify the individual.

One of the key factors that affects the accuracy of facial recognition scanners is the quality of the image or video being analysed. In order to achieve high accuracy, facial recognition scanners typically require high-resolution images or videos that are well-lit and show the individual's face clearly.

## Uses of Facial Recognition Scanners

Facial recognition scanners can be used in a wide range of applications, including security and surveillance, access control, and marketing research. In security and surveillance, facial recognition scanners can be used to identify individuals who are on a watchlist or to track the movement of people in a given area. In access control, facial recognition scanners can be used to grant access to buildings, vehicles, or other restricted areas to authorized individuals. In marketing research, facial recognition scanners can be used to track customer demographics and preferences.

## Limitations

Despite their potential uses, facial recognition scanners also have a number of limitations. One of the main limitations is that the technology is not yet able to achieve 100% accuracy, and there is a risk of false positives or false negatives. Additionally, facial recognition scanners can be affected by factors such as lighting, angles, and facial expressions, which can reduce their accuracy.

Privacy and security are also a concern with facial recognition scanners, as they rely on the collection and storage of personal data. In order to ensure the protection of personal data, it is important that facial recognition scanners are used in compliance with relevant laws and regulations, and that appropriate security measures are in place to protect the data.

## Facial Recognition Conclusion

Facial recognition scanners are a powerful tool for identifying individuals by analysing their facial features. They can be used in a wide range of applications, including security and surveillance, access control, and marketing research. However, the technology is not yet able to achieve 100% accuracy, and there are concerns about privacy and security.

# Introduction to Emotional Recognition

Emotional recognition technology is a rapidly developing field that aims to recognize and interpret human emotions through various means such as facial expressions, speech, or physiological signals. Emotion recognition technology can be applied in a wide range of fields such as healthcare, marketing, and human-computer interaction. In this report, we will take a closer look at the technology behind emotional recognition, its potential uses, and the limitations and challenges of this technology.

## How Emotional Recognition Works

Emotional recognition technology typically uses deep learning algorithms to analyse various signals such as facial expressions, speech, or physiological signals to identify emotions. There are several methods for analysing these signals, such as using image processing to analyse facial expressions, natural language processing to analyse speech, or using sensors to measure physiological signals such as heart rate and skin conductance. The algorithms used in emotional recognition are typically trained on large datasets of labelled data to learn the patterns and characteristics of different emotions.

One of the key factors that affects the accuracy of emotional recognition technology is the quality of the data used to train the algorithms. The more diverse and representative the dataset, the better the algorithm will perform on new, unseen data. Another important factor is the context in which the emotions are being expressed. The same facial expression or speech pattern can have different meanings depending on the context in which it is used.

## Uses of Emotional Recognition

Emotional recognition technology has a wide range of potential applications. In healthcare, it can be used to monitor patients' emotional states and detect early signs of depression or anxiety. In marketing, it can be used to analyse consumer emotions and preferences to improve the effectiveness of advertising and product design. In human-computer interaction, it can be used to create more natural and intuitive interfaces by responding to users' emotional states.

## Limitations and Challenges

Despite the potential uses of emotional recognition technology, there are also several limitations and challenges that need to be addressed. One of the main limitations is that the technology is not yet able to achieve 100% accuracy, and there is a risk of false positives or false negatives. Additionally, emotional recognition technology can be affected by factors such as lighting, angles, and the individual's emotional state.

Another important challenge is the issue of privacy and security. Emotional recognition technology relies on the collection and storage of personal data, and it is important that this data is handled in compliance with relevant laws and regulations, and that appropriate security measures are in place to protect the data.

Another challenge is related to the ethical and societal implications of using emotional recognition technology. There are concerns that the technology could be used to manipulate or exploit individuals, or to discriminate against certain groups. It is important to consider these implications and to ensure that the technology is used in an ethical and responsible manner.

## Emotional Recognition Conclusion

Emotional recognition technology is a rapidly developing field that has the potential to improve healthcare, marketing, and human-computer interaction. However, there are also several limitations and challenges that need to be addressed, including accuracy, privacy and security, and ethical and societal implications. It is important to continue to research and develop this technology in an ethical and responsible manner.

# Introduction

The code is a simple example of how you can use the Azure Face API to recognize emotions in an image in Python. The Azure Face API is a cloud-based service that provides advanced algorithms for detecting and recognizing human faces in images. This report will explain the code step-by-step, including the libraries used, the variables defined, the function created and how it works, and the test case used.

## Libraries Used

The code imports the requests and JSON libraries. These libraries are used to make HTTP requests to the Azure Face API and parse the JSON response, respectively. The requests library is a popular Python library for making HTTP requests. It is used to send a POST request to the Azure Face API. The JSON library is used to parse the JSON response from the API, which is in the form of a dictionary.

## Variables Defined

The code defines the subscription key and the endpoint for the Azure Face API instance to be used. The subscription key is used to authenticate with the Azure Face API and call the API endpoints. The endpoint is the URL for the Azure Face API service. The endpoint and subscription key are used in the headers and the body of the request.

The headers variable is created that contains the subscription key and the content-type of the image. The header is sent with the request to the Azure Face API, which contains the subscription key and the image type.

## Function Created

The code defines the function recognize\_emotion(image\_path) that takes an image path as input and uses the requests library to make a POST request to the Azure Face API endpoint, passing the image data, the headers, and the parameters which are to return the face attributes and specifically the emotion attribute.

The function first opens the image passed to it and reads it as binary data. Then it defines the request parameters, which in this case is only asking to return the face attributes, specifically the emotions attribute.

The function then makes a POST request to the Azure Face API endpoint for detecting faces, passing

# Explanation of the code with Images

The code I’ve submitted is a simple example of how you can use the Azure Face API to recognize emotions in an image in Python.

First, it imports the requests and JSON libraries. These libraries are used to make HTTP requests to the Azure Face API and parse the JSON response, respectively.

Text

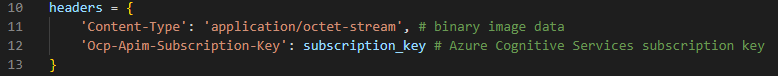
Description automatically generated

Then, it defines the subscription key and the endpoint for the Azure Face API instance to be used.

Text

Description automatically generated

It creates the headers variable that contains the subscription key and the content-type of the image.



It defines the function recognize\_emotion(image\_path) that takes an image path as input and uses the requests library to make a POST request to the Azure Face API endpoint, passing the image data, the headers, and the parameters which are to return the face attributes and specifically the emotion attribute.

Text

Description automatically generated

The function recognize\_emotion(image\_path) continues by defining the request parameters, which in this case is only asking to return the face attributes, specifically the emotions attribute.



Then, it makes a POST request to the Azure Face API endpoint for detecting faces, passing in the image data, headers, and parameters.

Text

Description automatically generated

The response from the API is parsed as JSON and the emotions are extracted from it. If there are no faces detected, the function returns None.

Text

Description automatically generated

Finally, the function is tested by calling it with an image and printing the returned emotions.

Text

Description automatically generated

# References:

**Facial recognition:**

*Face projects*. NIST. (2019, December 19). Retrieved January 15, 2023, from https://www.nist.gov/programs-projects/face-projects

*Face recognition technology*. American Civil Liberties Union. (2022, February 15). Retrieved January 15, 2023, from https://www.aclu.org/issues/privacy-technology/surveillance-technologies/face-recognition-technology

*Center on Privacy and Technology*. Georgetown Law. (n.d.). Retrieved January 15, 2023, from https://www.law.georgetown.edu/privacy-technology-center/

Ryan-Mosley, T. (2022, February 4). *This company says it's developing a system that can recognize your face from just your DNA*. MIT Technology Review. Retrieved January 15, 2023, from https://www.technologyreview.com/2022/01/31/1044576/corsight-face-recognition-from-dna/

**Emotional Recognition:**

Mallick, S. (2021, May 5). *Facial Landmark Detection: LEARNOPENCV #*. LearnOpenCV. Retrieved January 15, 2023, from https://www.learnopencv.com/facial-landmark-detection/

Author links open overlay panelM.BouhlalaEnvelopeK.AarikabR. AitAbdelouahidcS.ElfilaliabE.Benlahmarab, M.BouhlalaEnvelope, a, K.Aarikab, b, AitAbdelouahidc, R., c, S.Elfilaliab, E.Benlahmarab, & AbstractEmotions are by far crucial in the education field. (2020, August 6). *Emotions recognition as innovative tool for improving students' performance and learning approaches*. Procedia Computer Science. Retrieved January 15, 2023, from https://www.sciencedirect.com/science/article/pii/S1877050920317865

*Explore scientific, technical, and medical research on ScienceDirect*. ScienceDirect.com | Science, health and medical journals, full text articles and books. (n.d.). Retrieved January 15, 2023, from https://www.sciencedirect.com/

**Azure Cognitive Services:**

*Facial recognition: Microsoft Azure*. Facial Recognition | Microsoft Azure. (n.d.). Retrieved January 15, 2023, from https://azure.microsoft.com/en-us/services/cognitive-services/face/

Pablo Castro Distinguished Engineer, Priyanka Rawat Senior Product Marketing Manager, Andy Beatman Sr. Product Marketing Manager, Kate Browne Program Manager, Sarah Bird Principal Group Product Manager, Ali Dalloul Vice President Strategy and Commercialization, & Tom Keane Corporate Vice President. (n.d.). *Cognitive services: Azure blog and updates: Microsoft Azure*. Azure Blog and Updates | Microsoft Azure. Retrieved January 15, 2023, from https://azure.microsoft.com/en-us/blog/topics/cognitive-services/

*Facial recognition: Microsoft Azure*. Facial Recognition | Microsoft Azure. (n.d.). Retrieved January 15, 2023, from https://azure.microsoft.com/en-us/products/cognitive-services/face/

*Pricing - face API: Microsoft Azure*. Pricing - Face API | Microsoft Azure. (n.d.). Retrieved January 15, 2023, from https://azure.microsoft.com/en-us/pricing/details/cognitive-services/face-api/

Azure. (n.d.). *Azure/azure-SDK-for-python: This repository is for active development of the Azure SDK for python. for consumers of the SDK we recommend visiting our public developer docs at https://docs.microsoft.com/python/azure/ or our versioned developer docs at https://azure.github.io/azure-sdk-for-python.* GitHub. Retrieved January 15, 2023, from https://github.com/Azure/azure-sdk-for-python