Chapter 7:
Computer Vision

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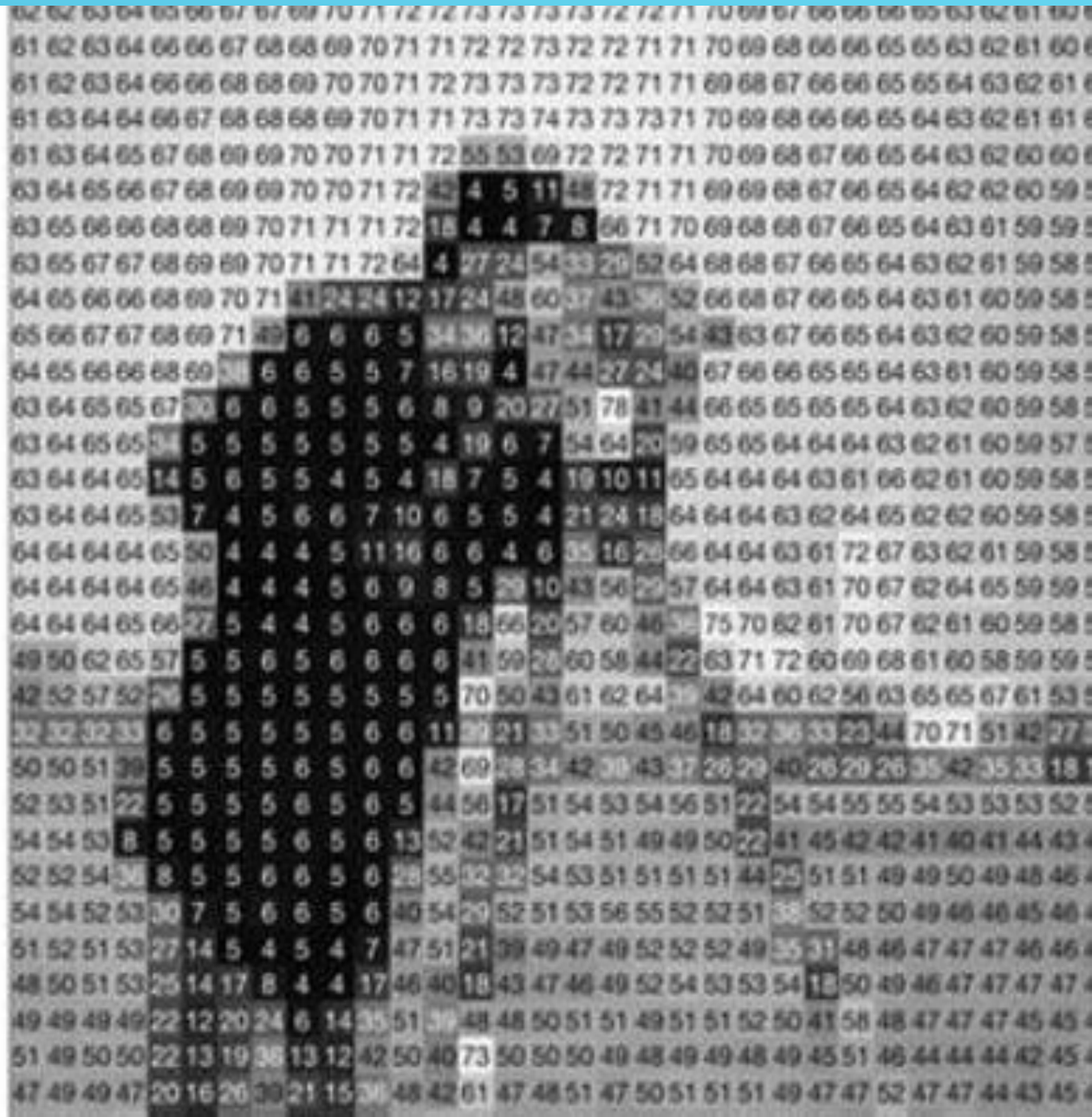
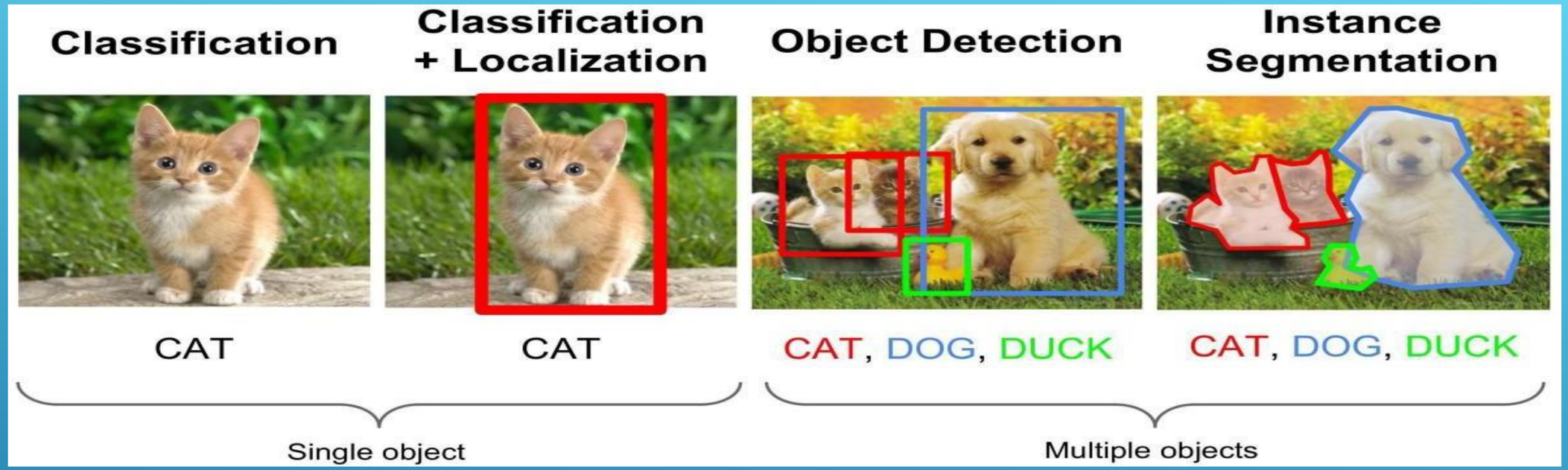
WHAT IS COMPUTER VISION?

- A field of Computer Science focuses on analyzing and processing visual images or videos intelligently like humans.
- Enable machines to learn and understand the images at pixel level through training and validation.
- Machines retrieve visual information, handle it & interpret the result.

HUMAN VISION vs COMPUTER VISION



SEEING RESULTS WITH COMPUTER VISION



- Object **Classification**: What category of an object is in this photograph?
- Object **Verification**: Is the object in the photograph?
- Object **Detection**: Where are the objects in the photograph?
- Object **Segmentation**: What pixels belong to the object in the image?
- Object **Recognition**: What objects are in this photograph and where are they?

HOW COMPUTER VISION WORKS?

Computer vision works in three basic steps:

Acquiring an image

Images, even large sets, can be acquired in real-time through video, photos or 3D technology for analysis.

Processing the image

Deep learning models automate much of this process, but the models are often trained by first being fed thousands of labeled or pre-identified images.

Understanding the image

The final step is the interpretative step, where an object is identified or classified.

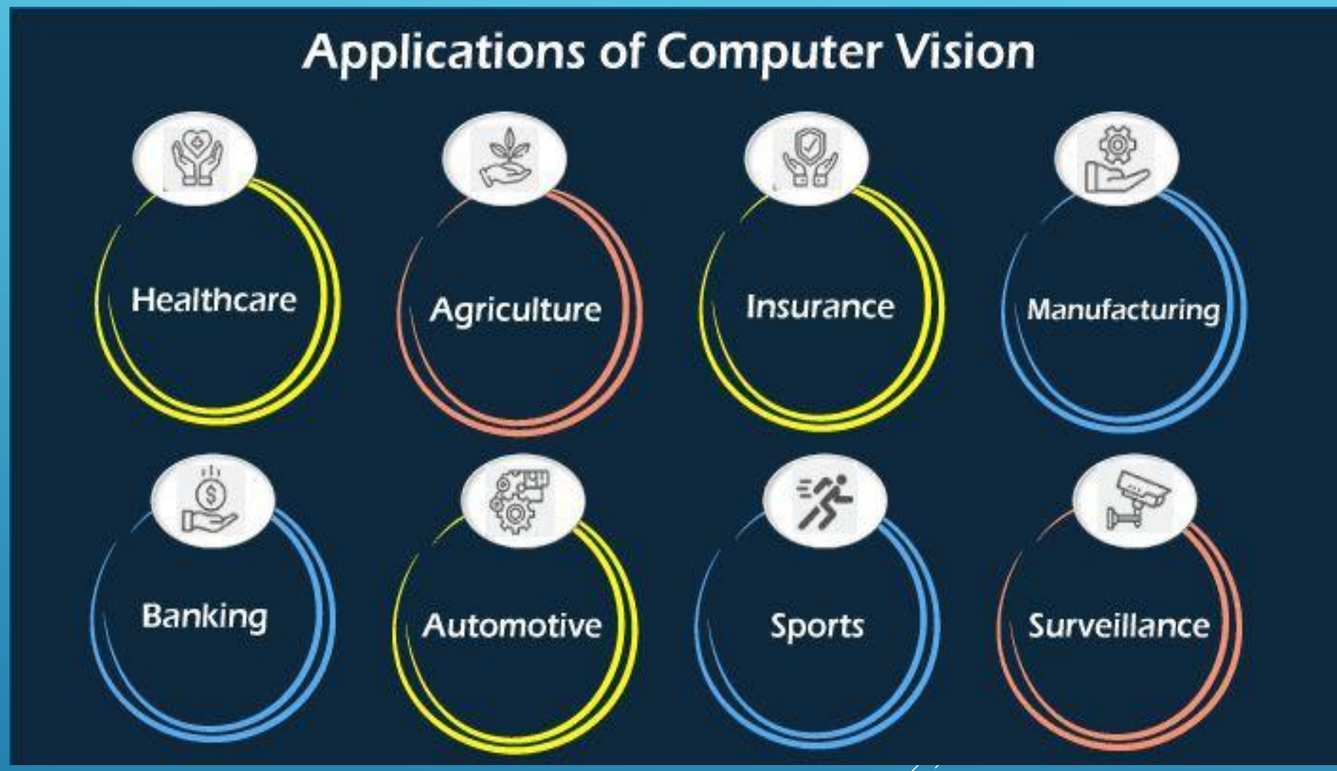
HOW COMPUTER VISION WORKS?

- Computer vision technology tends to mimic the way the human brain works. But how does our brain solve visual object recognition?
- One of the popular hypothesis states that our brains rely on patterns to decode individual objects. This concept is used to create computer vision systems.
- Computer vision algorithms that we use today are based on pattern recognition.
- We train computers on a massive amount of visual data—computers process images, label objects on them, and find patterns in those objects.
- For example, if we send a million images of flowers, the computer will analyze them, identify patterns that are similar to all flowers and, at the end of this process, will create a model “flower.”
- As a result, the computer will be able to accurately detect whether a particular image is a flower every time we send them pictures.

APPLICATION OF COMPUTER VISION

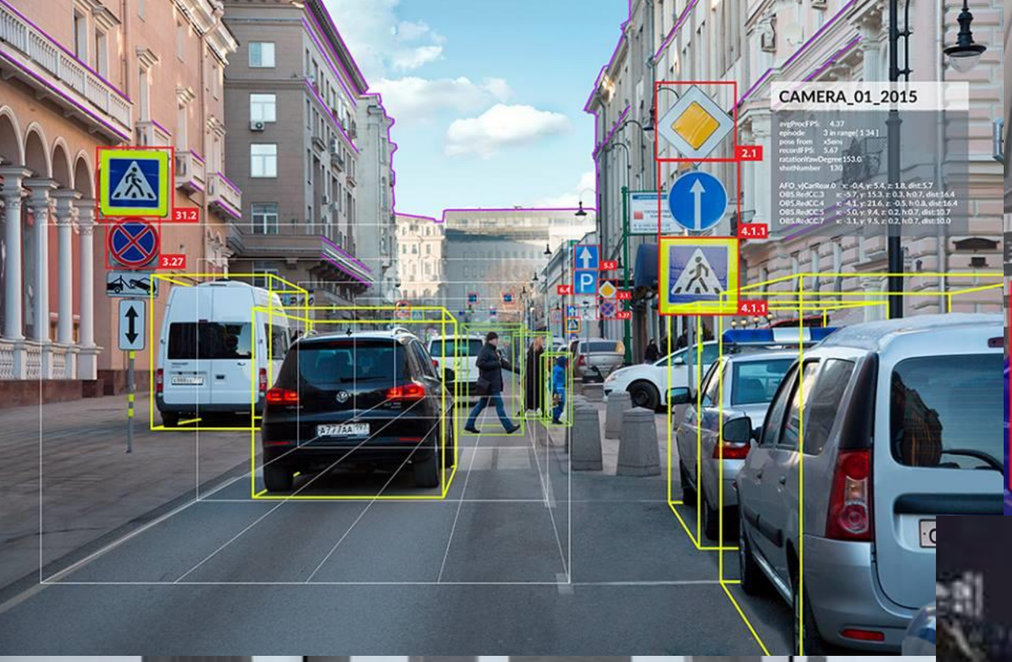
- Computer vision is one of the areas in Machine Learning where core concepts are already being integrated into major products that we use every day like:

  - ❑ Self-Driving Cars
  - ❑ Facial Recognition
  - ❑ Augmented Reality
  - ❑ Healthcare



COMPUTER VISION IN SELF DRIVING CARS

- Computer vision enables self-driving cars to make sense of their surroundings.
- Cameras capture video from different angles around the car and feed it to computer vision software.
- CV processes the images in real-time to find the extremities of roads, read traffic signs, detect other cars, objects and pedestrians.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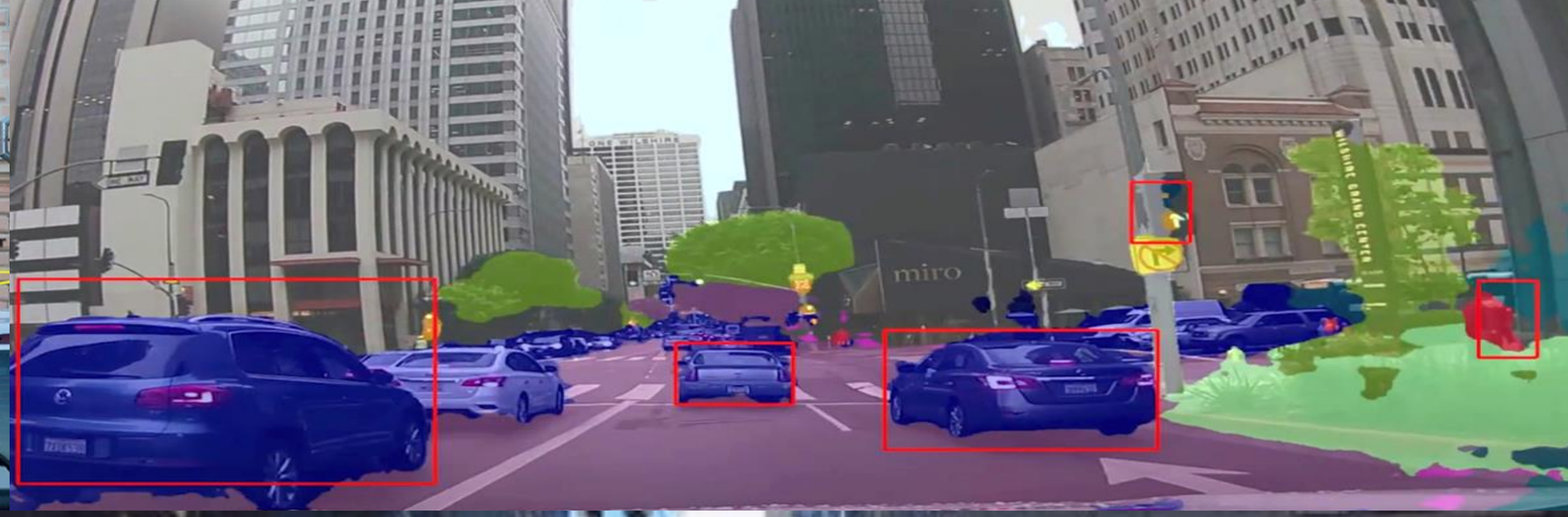
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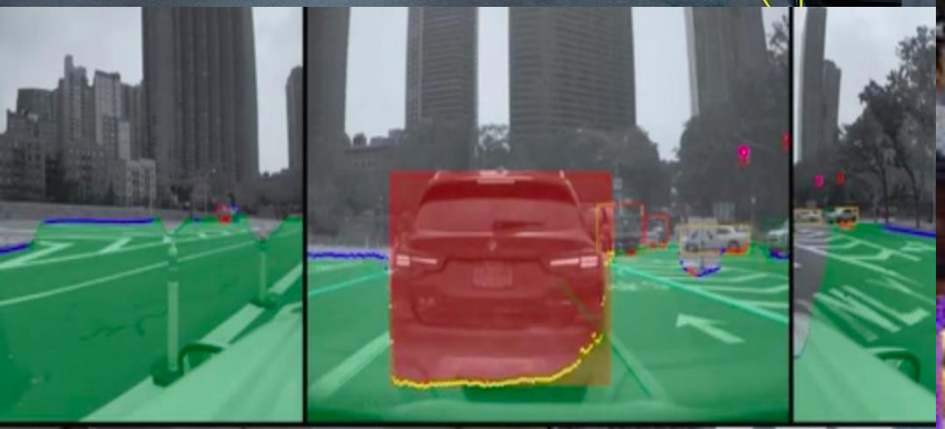

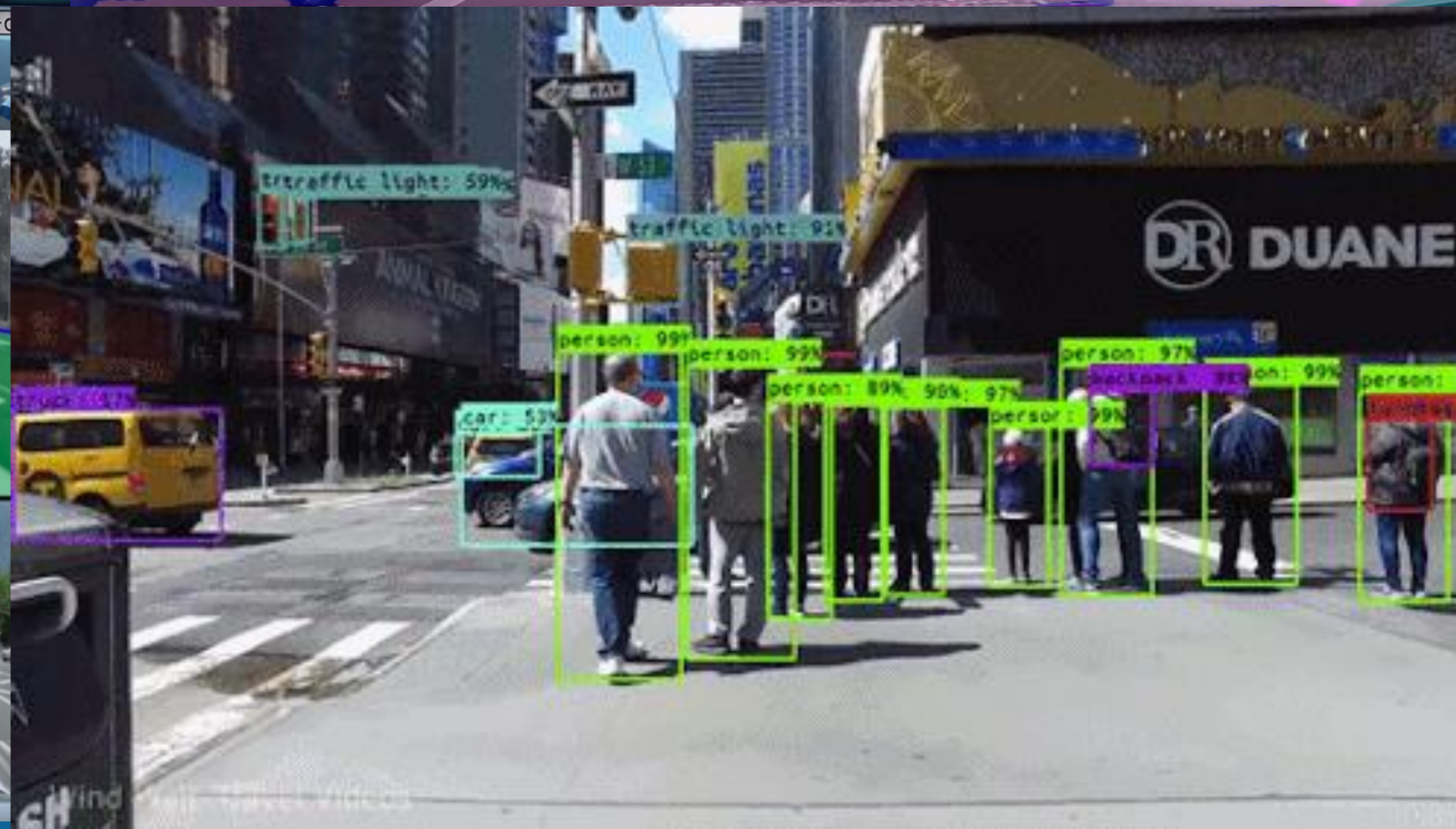
DR DUANE
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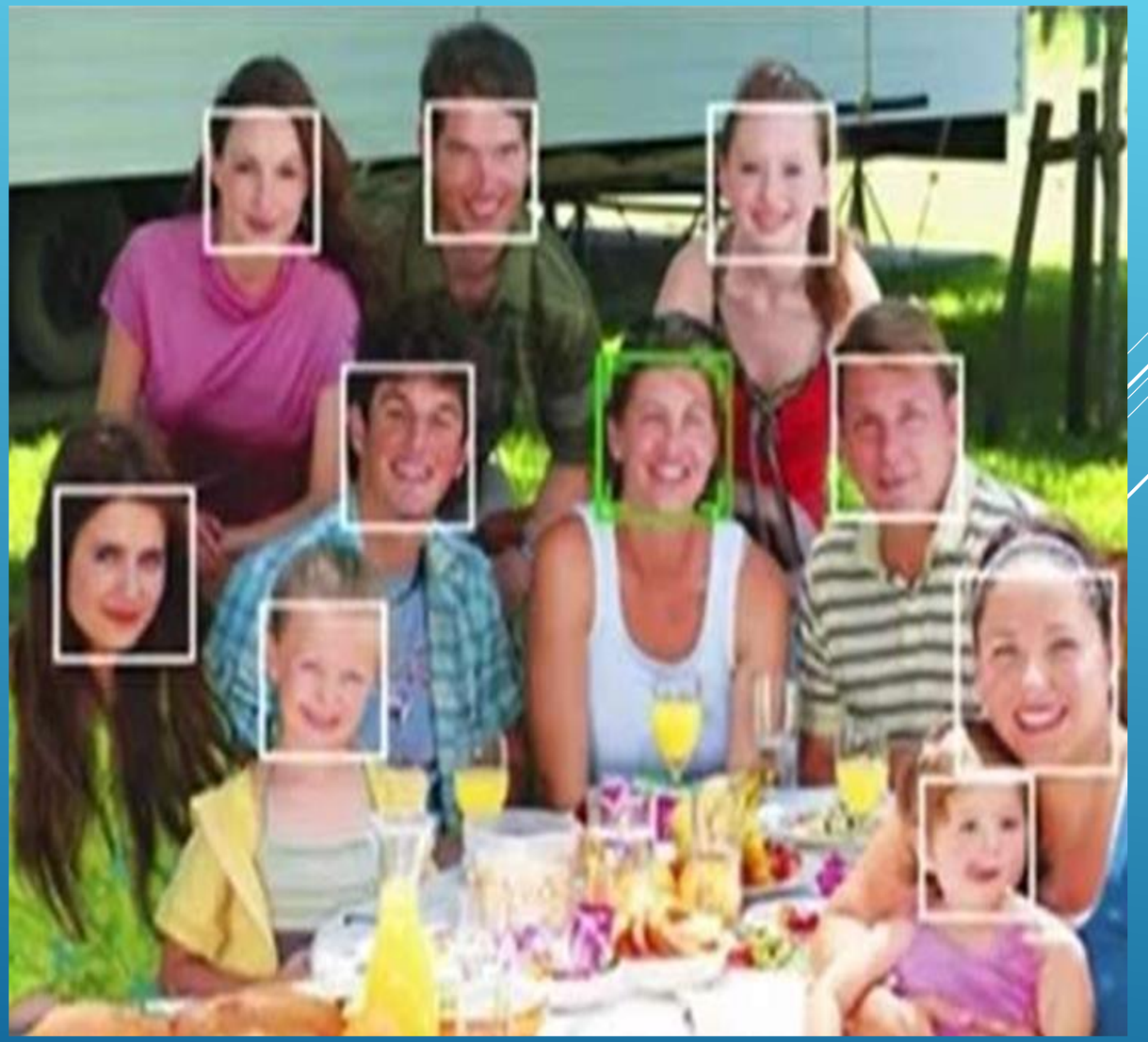
person: 99%
person: 99%
person: 89%
person: 98%
person: 97%
person: 97%
person: 99%
car: 53%

COMPUTER VISION IN FACIAL RECOGNITION

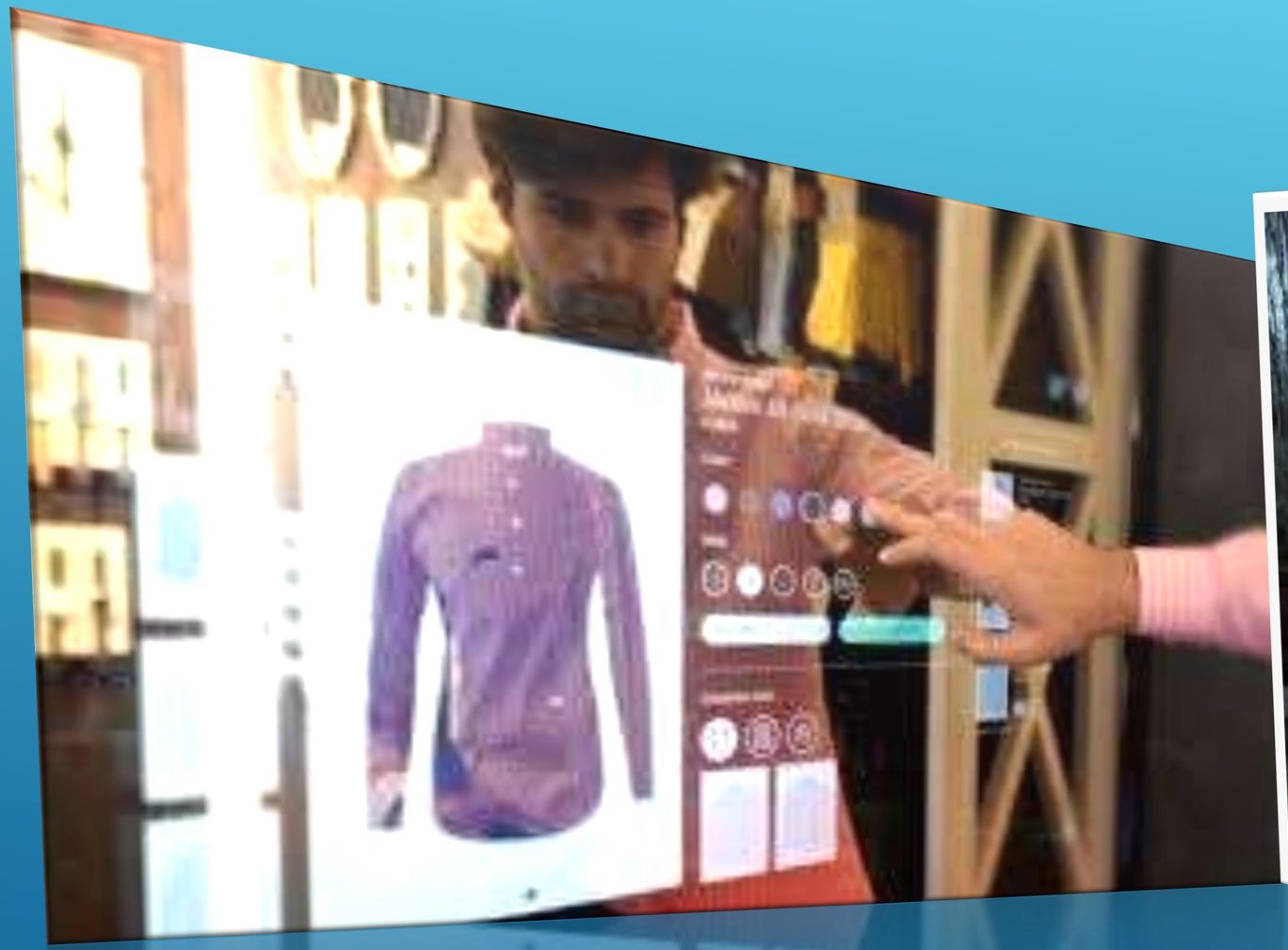
- CV enables computers to match images of people's faces to their identities.
- Social media apps use facial recognition to detect and tag users.
- Law enforcement agencies also rely on facial recognition technology to identify criminals in video feeds.



COMPUTER VISION IN AUGMENTED REALITY

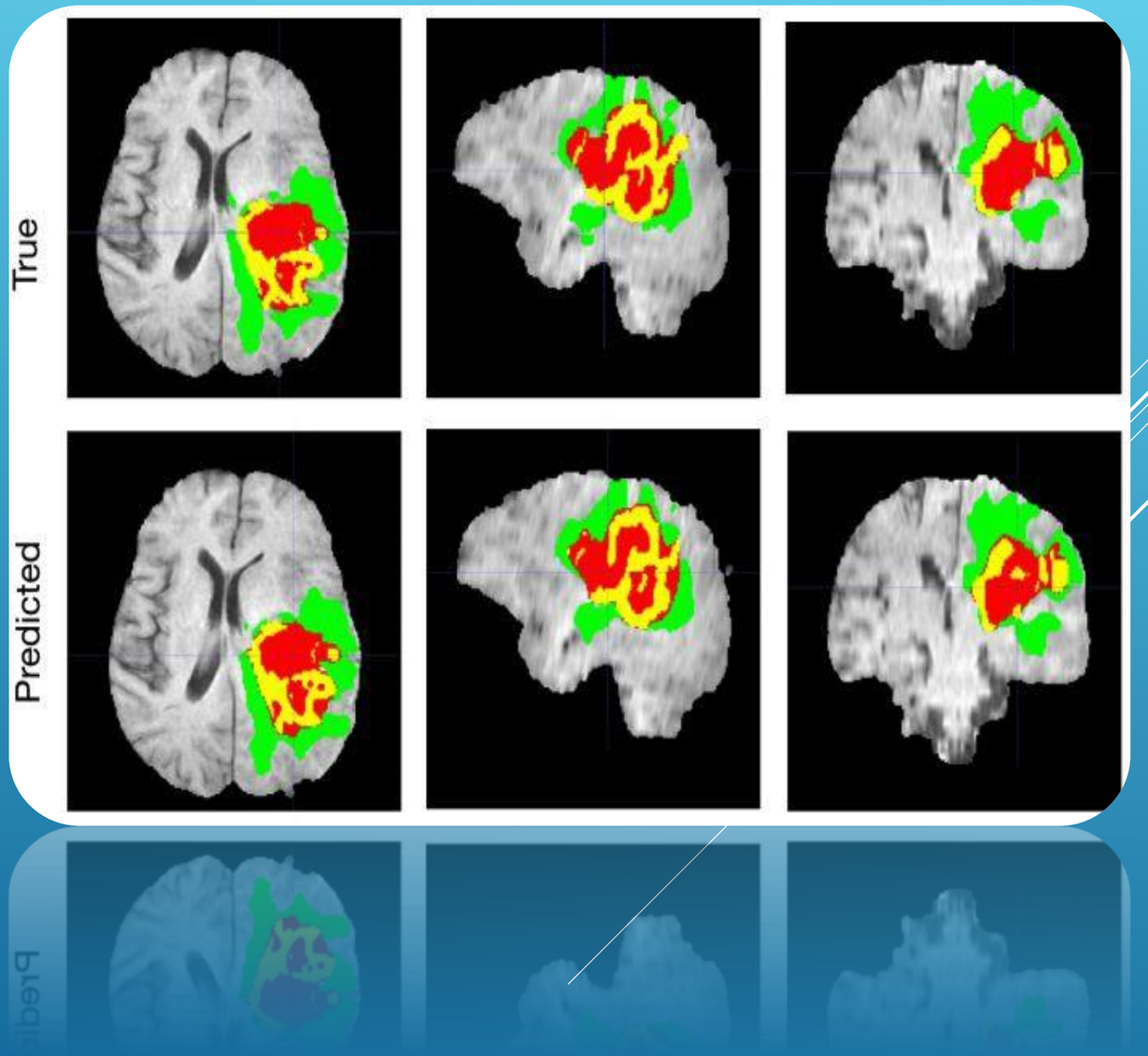
- Computer vision also plays an important role in augmented reality.
- **AR employs computer vision capabilities** in order to properly integrate the real and the virtual world.
- The integration involves the user's location, object-based interaction, 2D or 3D annotations, or precise alignment of image overlays.

DIGITAL TRIAL ROOMS



COMPUTER VISION IN HEALTHCARE

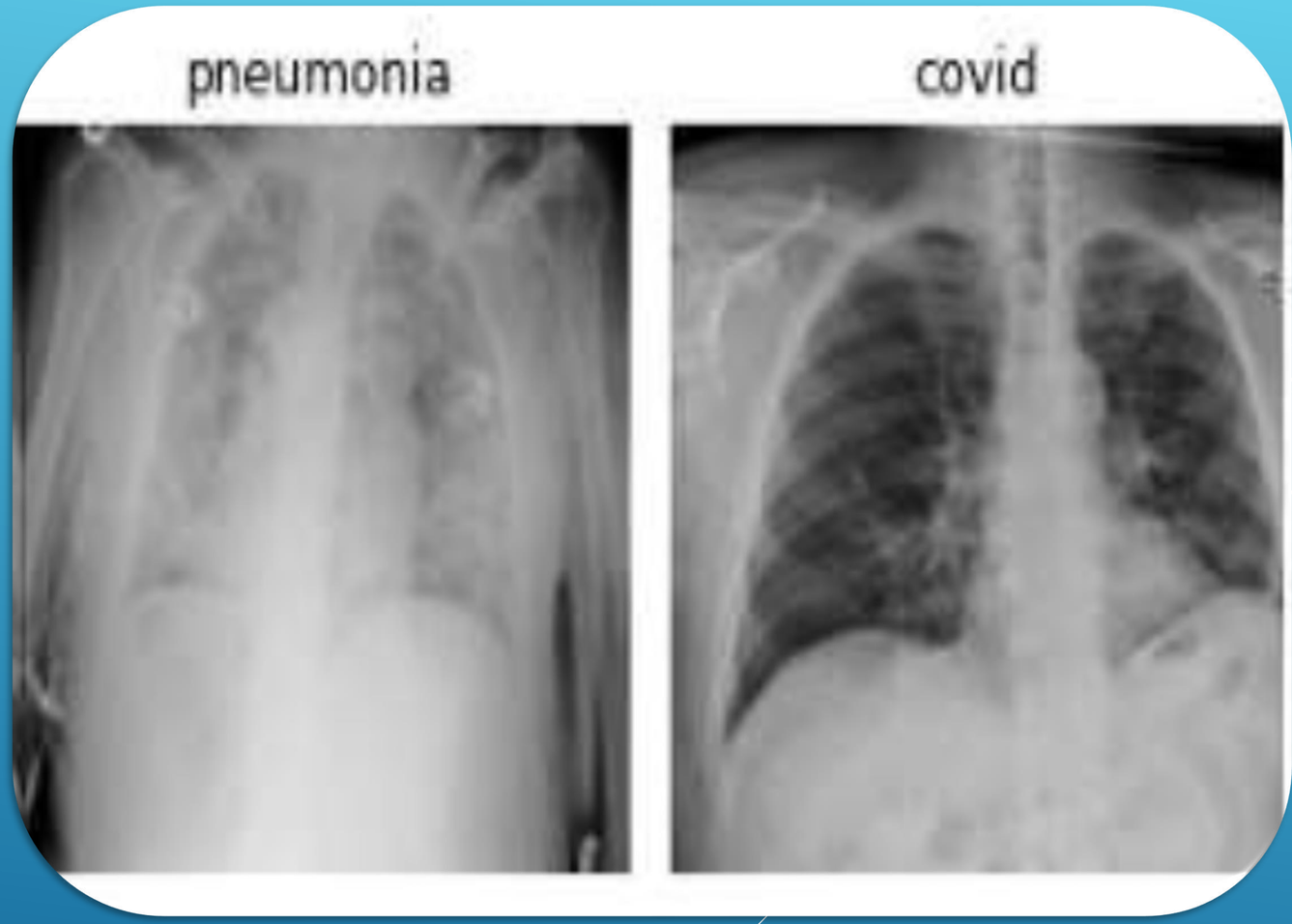
- Using Computer vision medical professionals can make better decisions regarding the treatment of patients.
- Some of the application areas are:
  - Blood loss measurement.
  - Cardiology
  - Tumor/Cancer detection
  - Timely detection of symptoms
  - Minimizing false positives
  - Prediction in Medical imaging
  - Surgeries



MEDICAL IMAGE ANALYSIS

- Recent CV technologies allow doctors to understand better CT scans, X-rays, etc.. by converting into 3d interactive models and make their interpretation easy.

- CV can detect COVID-19 cases using a chest x-ray. Moreover the deep learning methods can be used efficiently to distinguish Covid-19 from community-acquired pneumonia.



CHALLENGES OF COMPUTER VISION

- Because we’re not entirely sure how human vision works in the first place. It is difficult to build a machine that has a vision similar to humans.
- There are 5 major challenges to face while implementing computer vision and how can we overcome them
  - Proper knowledge of the domain.
  - Inadequate hardware
  - Poor data quality
  - Weak planning for model development
  - Time shortage

ADVANTAGES OF COMPUTER VISION

- **Process in a simpler and faster way**: it allows clients to check and access to their products.

- **Reliability**: computers and cameras don’t have the human factor of tiredness. The efficiency doesn’t depend on external factors such as illness or sentiments.

- **Accuracy**: the precision of CV will ensure a better accuracy on the final product.

- **A wide range of use**: We can see the same computer system in several different fields and activities. Example in factories with warehouse tracking and shipping of supplies.

- **The reduction of costs**: time and error rate are reduced in the process of CV. It reduces the cost of activities that computers will do as hundreds of workers.

DISADVANTAGES OF COMPUTER VISION

- **Necessity of specialists**: there is a huge necessity of specialist related to the field of CV in AI. There are a lot of work opportunities.
- **Spoiling**: eliminate the human factor may be good in some cases. But when the machine or device fails, it doesn’t announce or anticipate that problem.
- **Failing in image processing**: when the device fails because of a virus or other software/hardware issues, it is highly probable that CV and image processing will fail.