Computer Vision and Image Processing Fundamentals (IBM CV0101EN)

Course Overview

This Introduction to Computer Vision course is designed to introduce you to applying computer vision techniques to real-world problems. After completing this course, you will be able to apply image processing, traditional Machine Learning, and Deep Learning techniques to Computer Vision problems by integrating your solution into an application. You will also be able to deploy your computer vision application in the cloud and add them to your project portfolio.

This course focuses on real-world application and utilizes a hands-on approach to learning. There are two types of hands-on labs in this course: labs that use *Jupyter Notebooks* and labs that use *CV Studio*, a free tool designed specifically to help you learn the basics of computer vision. Both types of labs are provided to you by the IBM Skills Network Labs environment. You will use Jupyter Notebooks to quickly get started on image processing, Machine Learning, Deep Learning, and Computer vision tasks using pre-processed datasets. CV Studio-based labs let you focus on the actual learning by making it easy to upload, label, train, and test images train your model, and most importantly, integrate your model into a real application and, optionally, deploy your application on the cloud for others to use. This course is suitable for a variety of professionals and students intending to start their journey in Computer Vision who want an in-depth but simplified understanding of different techniques used in this field. We strongly recommend taking the Python for Data Science, AI & Development course before starting this course to get familiar with the Python programming language, Jupyter Notebooks, and popular libraries.

Important

Every module in the course has:

- Three to nine hands-on labs and assignments in Python and CV Studio
- A practice assessment to test your understanding of the materials
- A graded quiz that will contribute to 8% of the total grade for the course

In the final week, you will be given a project scenario in which you will be deploying your models to the cloud and a final exam. To certify completion, you will need to complete and submit your project for a peer review and complete your final exam. The project will be worth 20% of the final grade for the course and the final exam will be 40% of your final grade.

总结:

Week 1 - Introduction to Computer Vision

1.1 Introduction to Computer Vision

1.2 Applications of Computer Vision

1.3 Recent Research in Computer Vision

1.4 Brainstorming Your Own Applications

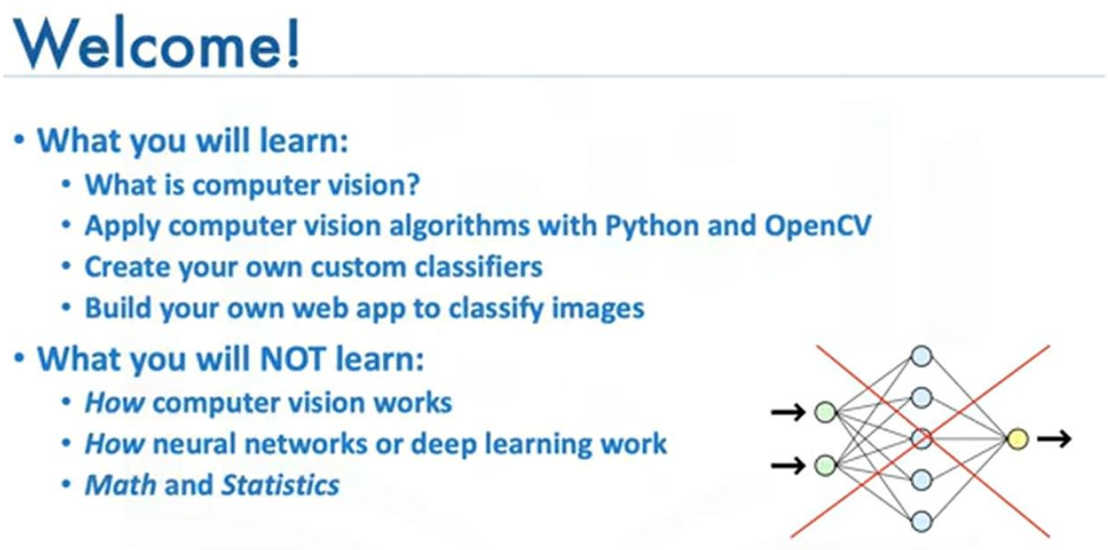
1.5 Articles

1.6 Computer Vision in Action

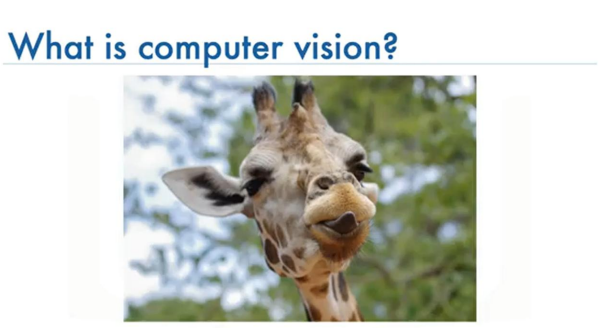
总结:

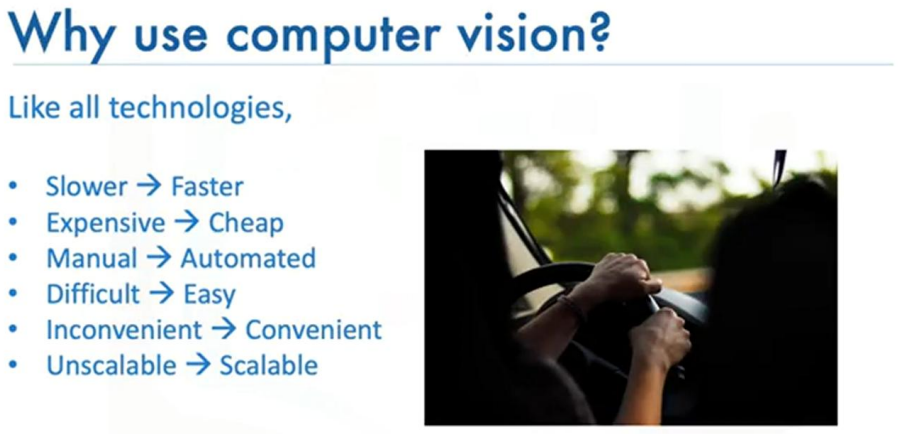
1.1 Introduction to Computer Vision

Welcome to introduction to Computer Vision. In this course, you will get introduced to the field of computer vision, and we'll learn about its applications. Further, you will also learn about the specialized methods and techniques that make up the field of computer vision, and we'll learn to implement these techniques using Python. So let's get started.



After completing this course, you will: understand what is computer vision, be able to apply and use computer vision algorithms with Python and OpenCV, know how to create your own custom classifiers that can be applied to business problems, build your own web app to classify images. What you will not learn, how computer vision works, how neural networks or deep learning work, math and statistics.



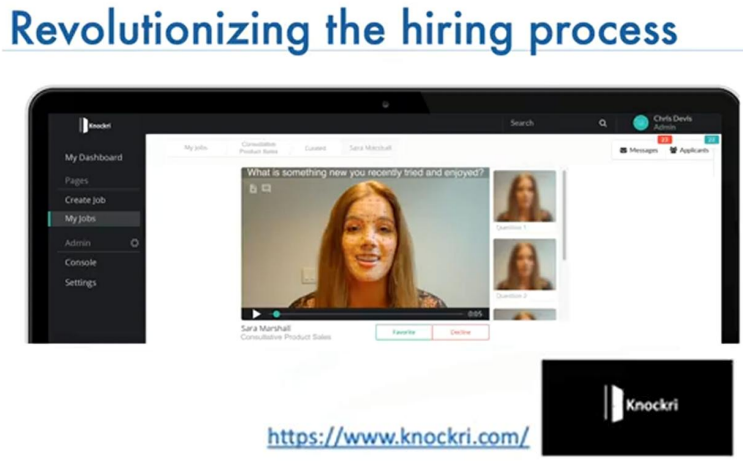


To start, let's begin by understanding by what exactly is computer vision? What do you see in the following image? We can clearly see that this is a picture of a giraffe. As humans, when we see an image, we can instantaneously recognize the contents of the image and interpret it. Computers on the other hand, aren't capable of doing so. As you may have guessed, computer vision is about this. It is providing computers the ability to see and understand images.

Now let's understand why computer vision is creating big waves in the industry. At a high level, the reason why computer vision or any technology is adopted, is because of some improvement. It could be that something slower becomes significantly faster, expensive becomes cheaper, manual becomes automated, difficult becomes easy, inconvenient becomes convenient, unscalable becomes scalable. One really groundbreaking change as we've seen in the news, is self-driving cars which frees up time for passengers through automation and can potentially save more lives than having human drivers. But in the course, we'd like to focus on smaller, more narrow solutions that use computer vision.

总结：

Computer vision has applications in all industries and sectors. We have seen that computer vision has made an enormous impact especially in industries like automotive, manufacturing, human resources, insurance, healthcare, and many more. In fact, there isn't an industry where computer vision does not have an application.



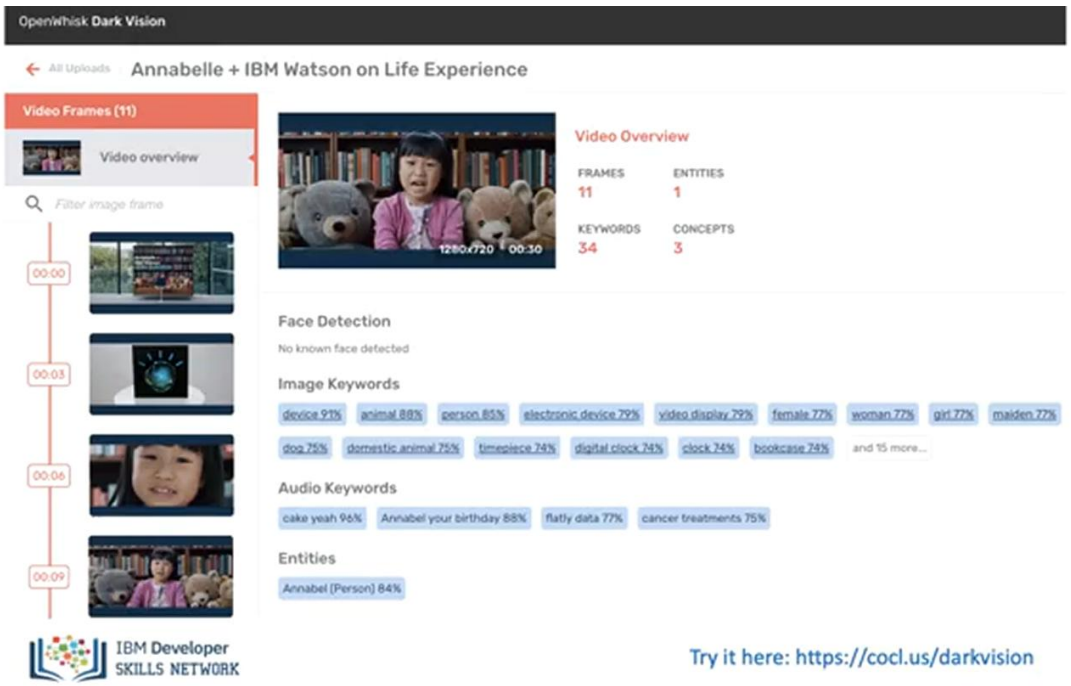
Now, let's dive right into how computer vision has been changing and disrupting industries.

If you don't know much about the oil and gas industry and you're not familiar with what's happening in the United Arab Emirates then you probably won't know of this company called ADNOC, that produces about 3 million barrels of oil and 10.5 billion cubic feet of raw gas each day. Founded in 1971, the Abu Dhabi National Oil Company or ADNOC is a diversified group of energy and petrochemical companies. This Emirati firm has previously used a labor intensive process for classifying the characteristics of rock samples requiring precious time and energy from expert geologists. After geologists fed high resolution rock images into a database, they used IBM Watson to analyze and properly identify classes of carbonate rock, giving ADNOC the ability to classify up to 25,000 thin section rock images per day. With Watson, they can run a set of images for a whole reservoir in minutes, saving their expert geologists precious time.

Let's look at another case of how computer vision is revolutionizing the hiring process. In the HR world, computer vision is changing how candidates get hired in the interview process. Knockri, a Canadian based startup, is making waves with their AI video soft skill assessment tool. By using computer vision, machine learning and data science, they're able to quantify soft skills and conduct early candidate assessments to help large companies shortlist the candidates. In this video, we saw how applications of computer vision are impacting our everyday lives.

总结:

1.2 Applications of Computer Vision



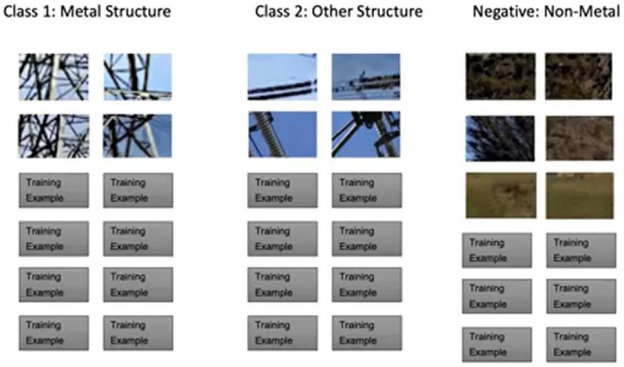
In this video, we'll talk about some of the applications of computer vision and how you can come up with some applications yourself.

What about sifting through videos? Have you ever tried looking for particular scene of a movie and had to to fast forward to skip around until you could find it? What about your own videos? What if they could be searchable? IBM created an example of how you could do this by tagging videos with keywords based on the objects that appear in each scene. Now imagine being that security company who's asking to look for a suspect in a blue van amongst hours and hours of footage. With computer vision and object recognition, searching through videos has become a thing of the past.

Example Raw image

Step 1: Divide raw image into grid to classify where in image to "zoom in"

Step 2: Create high-level "is it metal?" classifier. Train classifier on what to look for

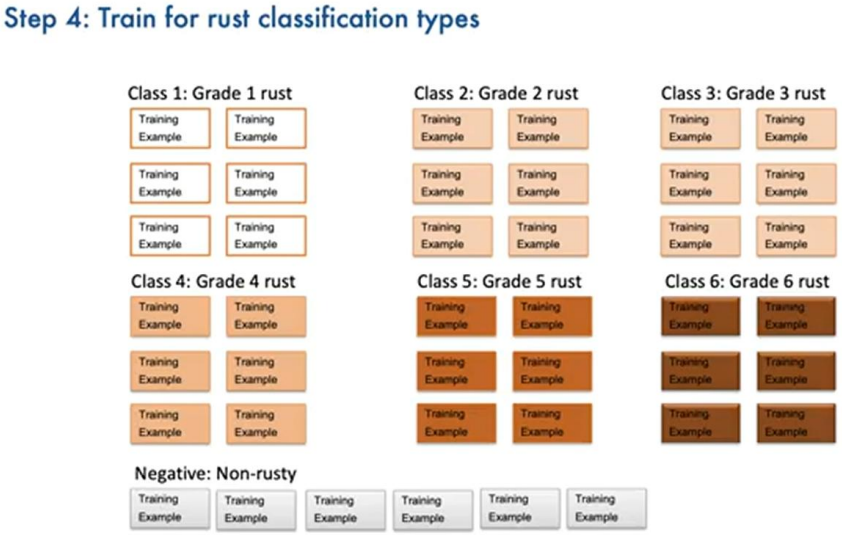


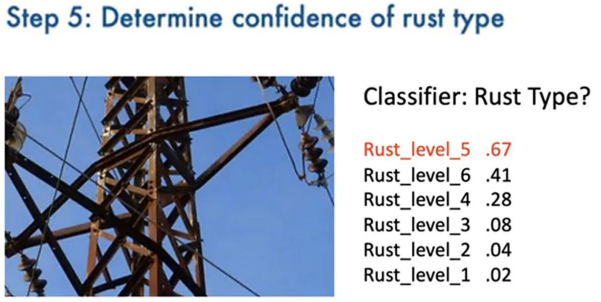
Step 3: Determine confidence if metal or not

Classifier: Metal Structure?

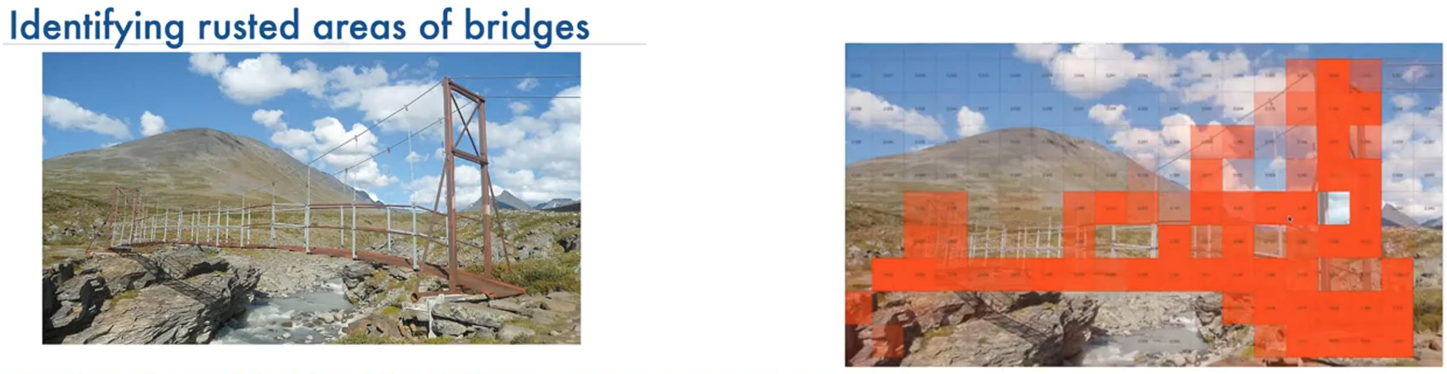
metal_structure .87
other_structure .13

总结:





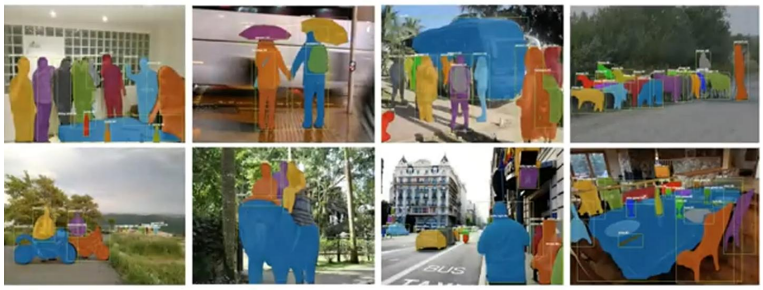
Now, other companies like insurance and civil engineering companies may have a completely set of different problems they want to tackle. Take for example this electric towers which require some degree of maintenance to check for degrees of rust and other structural defects. Certainly manually climbing up the tower to scour every inch and corner would be extremely time consuming and costly. Flying a drone with wires around doesn't sound particularly safe either. So how could you apply computer vision here? Well imagine that if you a person on the ground took high resolution images from different angles. Then, a computer vision specialist could cut up the images into a grid of smaller images. With each of the smaller images, you could then develop a custom image classifier that detects the presence of metal structure versus other structure versus non metal objects. With this custom metal classifier, you could then determine which areas of the image contain metal. But that wouldn't be enough to just detect metal. You could then create another custom classifier to determine the level of rust based on certain structural guidelines or criteria. So for example, you could have grade 1 rust, which cold be very minimal rust to grade 6 rust, which would be more severe. And finally, by sending the image through the second classifier to detect rust, it could then determine the level of rust for certain areas of the image that contain metal. Using metal classifiers and rust classifiers when scaled out across thousands or millions of images could save insurance companies millions of dollars.

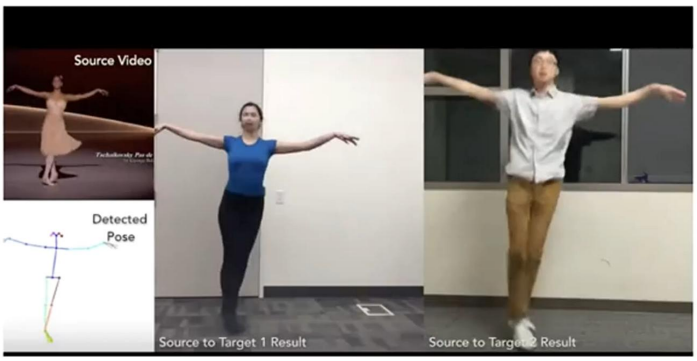


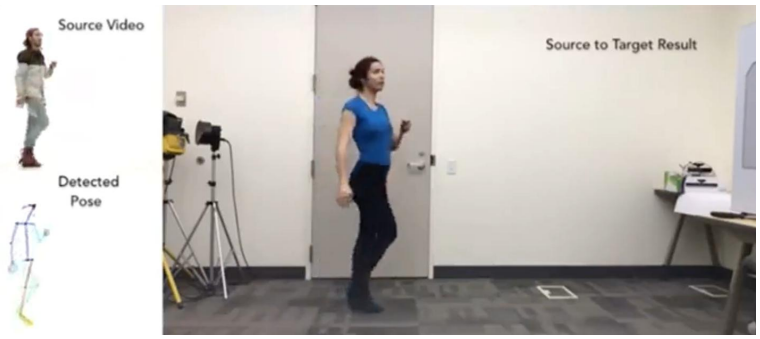
Another way to use such classifiers would be to directly map the areas of concern onto the image like this picture of a rusted bridge. You could create a grid like heat map to establish which areas are classified as rust on the image.
Furthermore, insurance companies often have to worry about grading the severity of certain claims, which could be a little difficult for people to classify. For example, the image of the left contains small areas of damage from hail and ice pellets during a storm. And with computer vision, damage could much more easily classified. This could potentially, save a lot of time and money spent in processing each insurance claim.
In this video, we saw some of the applications of computer vision in action and how computer vision techniques are used across industries. Thank you for watching.

总结：

1.3 Recent Research in Computer Vision







Now, let's talk about some active research that has been happening in the field of computer vision over the past decade. Researchers at Facebook are working on detecting objects in images. Detecting objects correctly and efficiently in images is an extremely important field in computer vision. This is because to make meaningful inferences in images and video streams, computers need to correctly detect objects in them as a first step. With the recent rise in popularity of self-driving cars, detecting objects in video streams has become important. Since videos from camera feeds of those cars need to be analyzed for the car to avoid obstacles and prevent collisions.

How cool is it to convert an image of a horse to a zebra and vice versa, or to change the scene of an image from summer to winter? Image to image translation is about this. The UC Berkeley Research Team is working on converting an image from one representation of a scene to another.

Everybody Dance Now is a project that uses computer vision techniques for performing motion transfer from one subject to another. Given we have a video of a person performing dance moves, the person's dance moves can then be transferred to an amateur target.

总结:

1.4 Brainstorming Your Own Applications

Start with the problem

- An app that can recognize different foods
- Blind people have difficulty identifying food in a grocery store

Start with the problem

Medicine:

- Training doctors to accurately detect cancer takes years of education and experience

Driving:

- Driving requires constant focused visual attention and accidents can be life-threatening
- Drivers are prone to distraction and long-distance drivers are prone to falling asleep

Start with the problem

Security:

- Looking for a suspect across days of surveillance footage takes time and is unscalable
- Detecting dangerous goods in x-rays at the airport is difficult and requires significant training and focused attention

Start with the problem

Manufacturing:

- Detecting defects in manufactured goods is labor-intensive and costly
- Employees are not using safety helmets or equipment despite strict regulations and reminders, and it is difficult for managers to constantly check their workers

Insurance:

- Calculating cost of damages from photos of accidents requires training and is labor-intensive

So what are some ideas that you might be able to come up with? In this course, you'll have opportunities to create your own computer vision applications. So it's good to start thinking about it now. I find it most helpful If you start not from the solution, but with an existing problem. So instead of saying something like, I want to create, use computer vision to recognize different food. You should think, home, visually impaired people have difficulty identifying food in a grocery store. How could I use computer vision to tackle that problem?

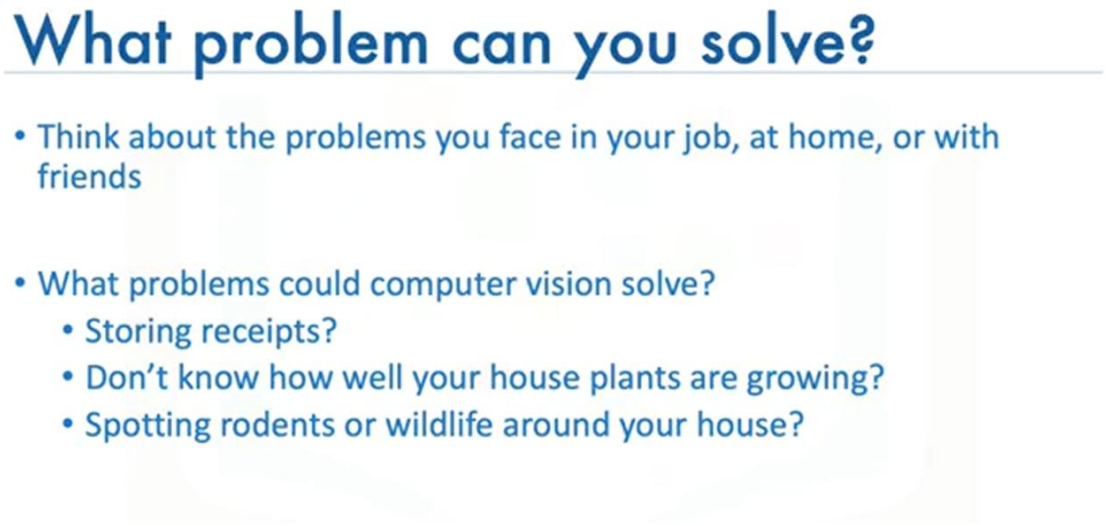
So let's think about somehow to identify existing problems. It often helps if we narrow it down by industry. Let's start with the easier ones we can relate to. In the field of medicine, what is one of the most difficult and time-consuming tasks? Training doctors to accurately detect cancer, training and developing that expertise. What about driving? Well, certainly driving is an easy one because we can't look at everything at the same time. Driving requires constant focused visual attention, and the consequences are pretty severe if mistakes are made. Furthermore, long-distance drivers are prone to falling asleep at the wheel.

What about the security and surveillance industry? We talked about this earlier, but looking for a suspect across hours and hours of footage consumes a lot of time. On a different note, detecting dangerous goods in X-rays at the airport is difficult, and the consequences of making a mistake could pose significant security risks.

In the manufacturing industry, thousands or tens of thousands of products could be built or assembled in some supply chains. Trying to make sure each item is of high-quality could be very difficult and labor-intensive. How might computer vision help?

Furthermore, from an insurance and work safety perspective, often construction employees are found not wearing appropriate safety helmets, equipment, or vests when working with heavy machinery. How might computer vision help ensure compliance? In addition for insurance, car accidents happen all the time, but evaluating the damage for each car in the accident takes time and expertise. It also depends on the make, model, and year of the car among other things to establish cost of replacement. How might computer vision help there?

总结：



So hopefully that has given you some ideas to start thinking about the ways computer vision could be used in various industries, and how you might be able to start thinking of your own problems that could be solved with computer vision. To make it easier for you, think about the problems you face in your job, at home, or with friends. What problems could computer vision solve? Do you ever have problems finding receipts for items you want to return or exchange? Do you ever wonder what kind of plant you have in your backyard, or how you might be able to keep track of the growth of your plants at home? Do you have rodent problems? Or perhaps like we do in Toronto, Canada, problems with raccoons diving into our garbage bins? There are endless possibilities with computer vision. So start asking around to see if you can make your life, your friends lives, or your work better or more convenient with computer vision.

总结:

1.5 Articles

Articles

READINGS

We encourage you take some time to explore the following two readings. These are just two of the countless ways in which Computer Vision continues to revolutionize industries across nearly every domain.

IBM Research Releases 'Diversity in Faces' Dataset to Advance Study of Fairness in Facial Recognition Systems

https://www.ibm.com/blogs/research/2019/01/diversity-in-faces/

Abu Dhabi National Oil Company (ADNOC): Enhancing accuracy, consistency and speed of rock analysis to support better decisions

https://www.ibm.com/case-studies/abu-dhabi-national-oil-company-adnoc

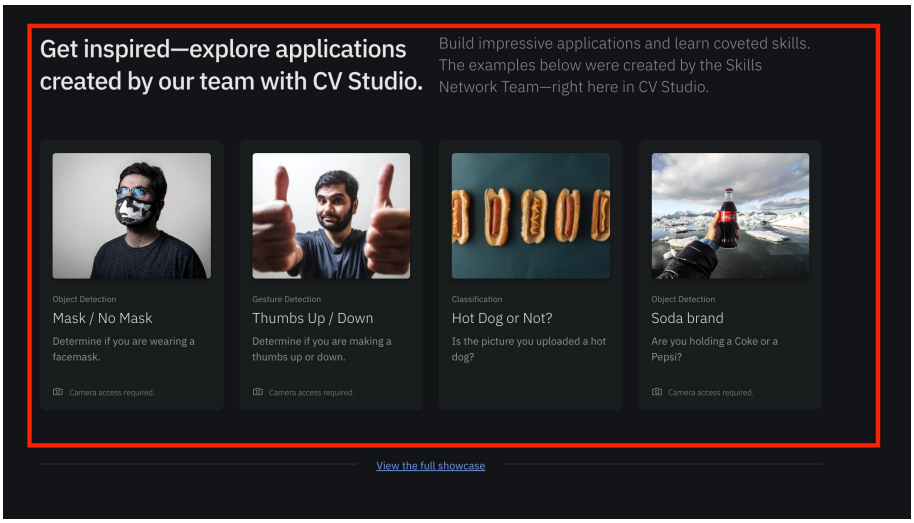
总结:

1.6 Computer Vision in Action

Computer Vision in Action

There are two parts to building a Computer Vision application, developing the model and deploying it via an application. CV Studio is a Computer Vision learning tool to build your Computer Vision application in an interactive web application. Once you have developed your Computer Vision application, you can deploy it. You can check out some of the demos on CV Studio at the following link.

You can then click on some of the demos in the course as shown in the following lab:



https://vision.skills.network/?utm_medium=Exinfluencer&utm_source=Nurture&utm_content=000026UJ&utm_term=10006555&utm_id=SkillsNetwork-Courses-IBMDeveloperSkillsNetwork-CV0101EN-SkillsNetwork-19816089&utm_email=Email&utm_campaign=PLACEHOLDER

总结: