REPORT AUGUST 06

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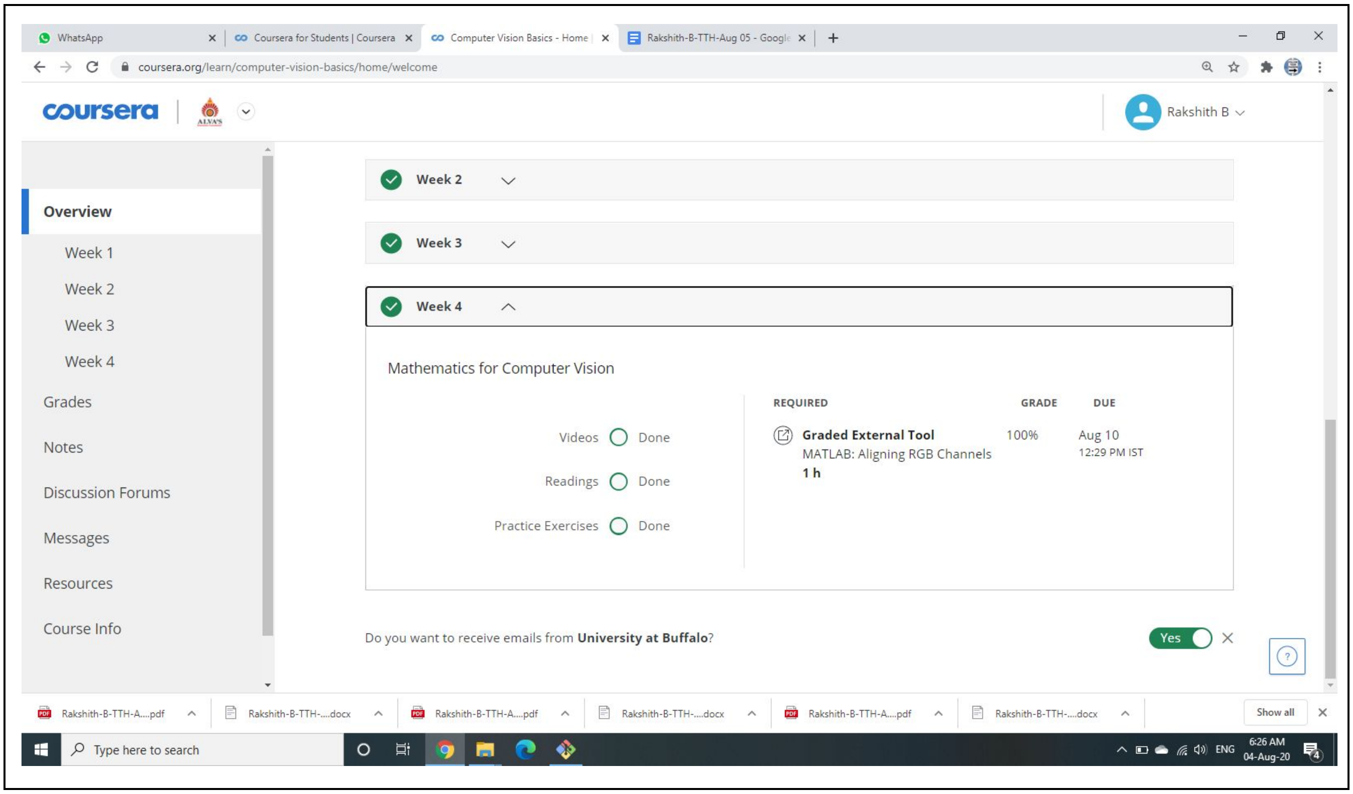
Image of the Session



Computer vision happens to be a computer science subject that requires a lot of math. In general, the more the better. You can see all kinds of math apply in computer vision, particularly, what we really need is linear algebra, matrix for example, matrix analysis, calculus, you need to analyze. Linear algebra is for 3D vision. If you work on 3D vision, how we get the 3D. You need a lot of linear algebra because it's a project ion from 3D to 2D, and we want to go back from 2D to 3D. There are a lot of linear algebra there , and the calculus. So we need to analyze the image, the video. We need to do a mathematical analysis. So that's a calculus optimization. So for computer vision many tasks including machine learning, and in many situations they can be optimization problem. For example in deep learning in terms of the training is to optimize a highly non linear function, to make it work. So we need optimization tools a lot. Probabilities and statistics, because in computer vision the world is in many situations is not certain, you have to use a probability model to model your image, your real world. So those kind of useful methods as the most commonly used tools in computer vision among others. As a beginner people may feel there are a lot of math there, but the truth is that I really like the computer vision subject in this sense is that, for every math you can find a physical modeling computer vision. If you just don't do math for math, every equation, math equation, for example you are doing your math course, they have a physical meaning in the vision problems. So it can motivate you to think about what are the equations meaning, and whenever you solve it if you already get it, you can see the results. That's more exciting than just learning a math course to me.

Before we begin our journey into the core concepts of computer vision, it is important to be equipped with several mathematical tools. In this lecture, we shall go with the concepts of numbers, sets, scalars, vectors, and matrices in detail.

Through the use of Linear Algebra and other mathematical models, the field of Computer Vision has expanded rapidly. Currently, Computer Vision is used to solve vital problems in a vast array of fields including medical imaging, surveillance, face and object detection and identification. The techniques that Linear Algebra provides for solving complicated mathematical models, are essential to solve problems in each of these fields. When utilizing Linear Algebra to solve problems in Computer Vision, Least Squares is the most commonly used tool. Computer Vision often deals with attempting to interpret real-world data such as the intensities of an image. These values are error-prone causing one camera's interpretation of a scene to appear slightly different from another cameras interpretation. Such as the case for image matching.

The singular Value Decomposition is the most common and useful Linear Algebra technique in Computer Vision. The goal of Computer Vision is to explain the three-dimensional world through two-dimensional pictures. In the real world, most of these pictures will produce both square and non-square singular matrices and transformations. Inverting transformations from two dimensions to three dimensions, will therefore not be completely accurate but they can be estimated quite well through Singular Value Decomposition.

Calculus is the mathematical study of continuous change, in the same way that geometry is the study of shape and algebra is the study of generalizations of mathematic operations. Calculus has two major branches, differential calculus, concerning instantaneous rates of change and slopes of curves. And then we have integral calculus. As an image is a 2D function of intensities, it is obvious to use the principles of calculus in solving computer vision problems. Computer vision uses derivatives, integrals and partial differential equations extensively in several low and mid-level vision tasks.

Artificial intelligence deals with making decisions in the real world, often in the presence of great uncertainty. We can conjecture that the visual world is uncertain and therefore should be described through the language of probabilities. Several standard problems in computer vision, can look up the probabilistic methods for their solutions. An understanding of basic probability theory is critical to the understanding of modern artificial intelligence and related fields such as computer vision.

Computer vision benefits from computer science algorithms, and numerical methods for mathematical optimizations. Dynamic programming is used in applications pertaining to stereo matching and seam carving. Graph algorithms are used extensively in image segmentation. Many computer vision problems are formulated as energy minimization problems. In this lecture, we shall go over several computer science algorithms, and numerical methods, that come in handy while solving some basic computer vision problems.

Well, right now, there's tremendous activity in cloud computing, computer vision in the cloud. So for example, in big cloud players like Microsoft and Amazon, offer very sophisticated computer vision capabilities in there as part of their Cloud Compute, so that beyond just using their computers, you can use their algorithms. We had a great talk here this week from Chris Adzima of the Washington County Sheriff's Office, Portland, Oregon. He's an Information Systems Analyst for the Sheriff's office. With no computer vision background but leveraging cloud APIs and cloud compute resources, in a matter of two or three months, he was able to put together a quite robust face recognition algorithm, which his Sheriff's department now uses to compare photos that officers get at arrest time to mug shots of people previously arrested or to compare surveillance photos of people who've committed theft to mug shots, and it's already resulting in these Sheriff's deputies catching bad guys. So to me, that's amazing. To think that somebody who has no background in computer vision, in a matter of a few months, was able to not put together a toy application but put together a robust application that's been deployed in the field and is delivering results, that's quite revolutionary and very promising I think in the direction of enabling many, many people to create their own applications.