Applied Accelerated Artificial Intelligence
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End to End Accelerated Date Learning
Lecture - 32
Optimizing Deep Learning Training: Transfer Learning Part - 1

I want to welcome everybody to today's lecture and we will be discussing Optimizing Deep Learning Training and under that will emphasize on Transfer Learning. So, today our focus is on Transfer Learning.

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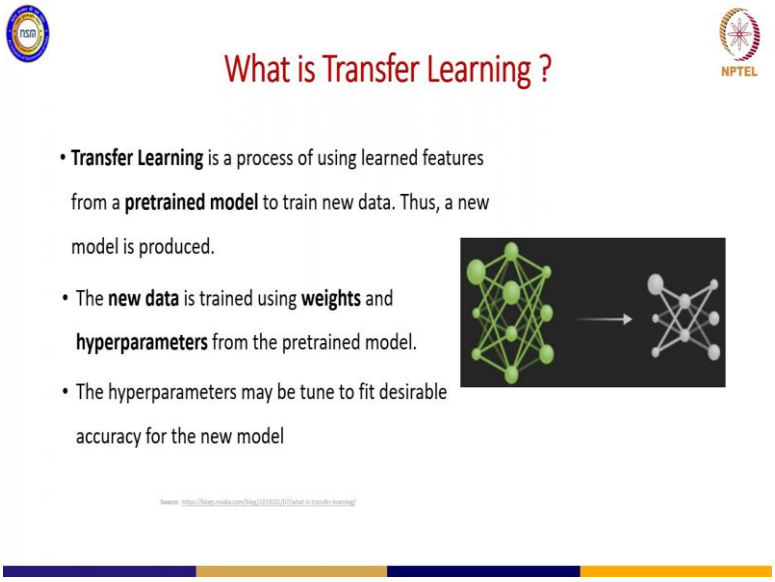

Let me proceed I want to tell you that we would not waste much time today it would be more of hands on than the theoretical part. So, first of all we want to know what we mean by transfer learning? So, transfer learning is a process where you have your whole new data and there is an existing pretrained model which you can use your new data to be trained using that existing pretrained model. So, in a simple term we can say it is a process of using learned features from already trained model.

So, that is the process of what transfer learning and now you do that you do that by using the weights and the hyperparameter of the pretrained model to achieve that purpose. Then in order to get a good results or desirable accuracy, so what you do is to also tune

for the hyperparameter of the already trained model which will refer to as pretrained model.

So, this give you the ability not to start building your network layer from the beginning, your deep neural network rather that is you are thinking of ok. How many convolutional layer do I need to have how many pooling layer do I need to have you do not need to bother about that again, because there is an existing pretrained model which you now bring your new data you supply into the existing pretrained model which would give back to the new model with your new data.

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So, why Transfer Learning? Why do we need to use transfer? And one of the main reason is that you do not need to build your model from the scratch again, because this is very important. Nowadays where there are complex tasks to solve and those complex tasks require large models to be built so and for you to start from the beginning is a lot of labour and a lot of brainstorming.

So, since there are large deep neural network existing which are robust their state of the heart. So, we can leverage on those existing deep neural network by bringing our own new data and using that existing network deep neural network to train our own data and we can harvest our results.

So, one of the major advantage you get is that it requires less data to train you only need to use lesser data based on the complexity of the tasks you want to achieve. And why do you need that? Why do you need to use less data is because the already pretrained model has been trained with large data before.

So, the model is as the ability to recognize variation in data and it is it has the ability to lend those futures. So, you already know those futures already. So, when you want to train your own new data you do not need large data which match the complexity of the task you want to train.

So, you only need just a handful of data what I mean handful of data I am not saying, so small data about a sufficient data to level. What you used to train? So, it require less data than the usual one then also you have the time of training of your data will be reduced that is you have speed training time speedy training time, because why some of the things that your data supposed to your model supposed to learn if you are building it from the scratch.

They already pretrained model they already have those features already know how to start those features. So, it does not need to take long for it to start those features, so it learn faster and lastly is that it saved costs. So, especially we look at it from the domain of computer vision, we can see computer vision one of the main challenges there is data is scarce data is expensive based on the tasks you want to perform.

So, if we look at the health domain data there is also scarce. So, when you have a pre trained model which already has those capacity it is been trained with large data before. So, you do not need to use much data, so it saves you cost of buying data that you need you require to train your model.

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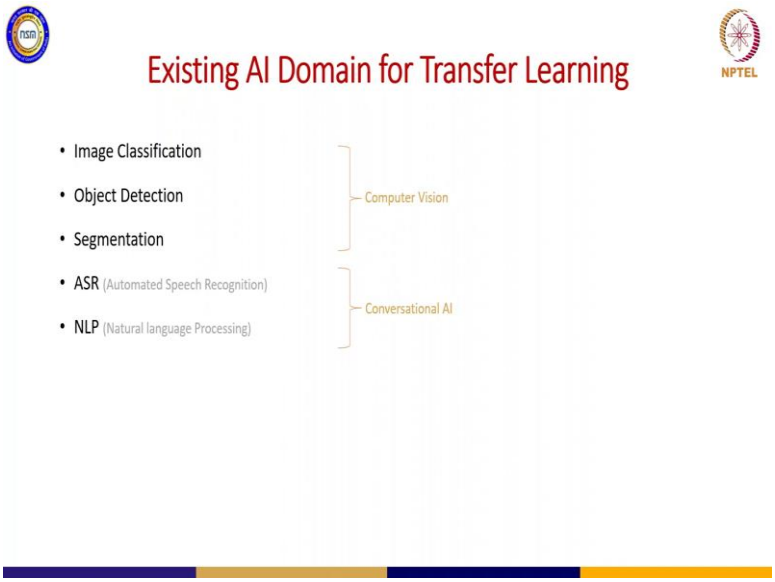

We will look at Existing AI Domain for Transfer Learning. What are the domains? Where we can use transfer learning in high we have the image classification they are transfer learning model which exists for that also object detection, there is transfer learning which also exists model exist in that also.

Then segmentation image segmentation transfer limit also exists there. So, those threes are classified under computer vision and then there is the automatic speech recognition there is also a model for that and also the NLP Natural Language Processing. So, these 2 also they classify under conversational AI they this domain they have transfer learning model transfer learning is possible in this domain.

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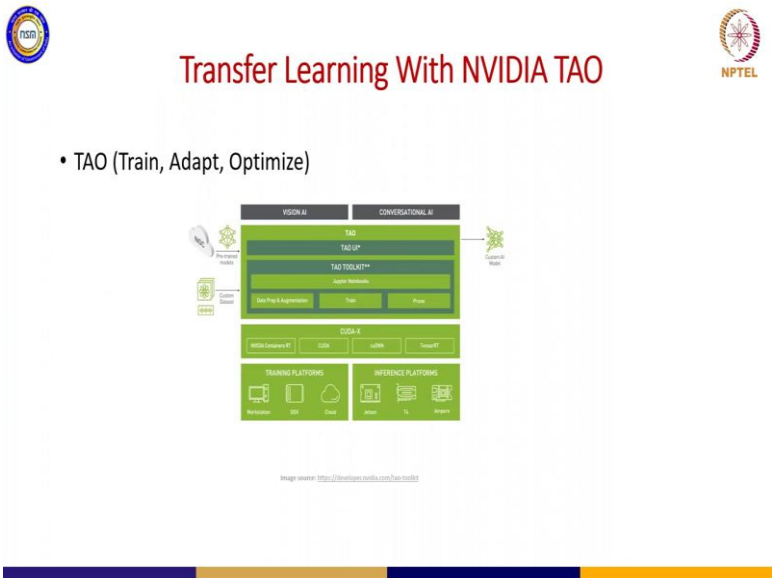

We will talk about transfer learning with NVIDIA TAO this is a framework which we can use as for achieving transfer learning and TAO means Train, Adapt, Optimize. So, you can get your pretrained model from NGC I will show you I was talk about NGC as we move further and you will also have your custom data this is your custom data.

So, once you pull your pretrained model from the NGC, from the NGC sorry let me see if that is ok you pull your pretrained model from the NGC everything go goes into TAO inside TAO you can do data preparation and augmentation you can take train inside the toolkits and then you prune after you prune then you have your customized AI model.

So, all of this will run on the CUDA using your container and then the CUDA is there cuDNN for the training, then when you want to inference you can proceed further to optimize using what we call tensorRT and the training can be done on your workstation on DGX on the cloud you can reference, inferences on this platform as well. So, for more information on this you will be able to you can visit this link.

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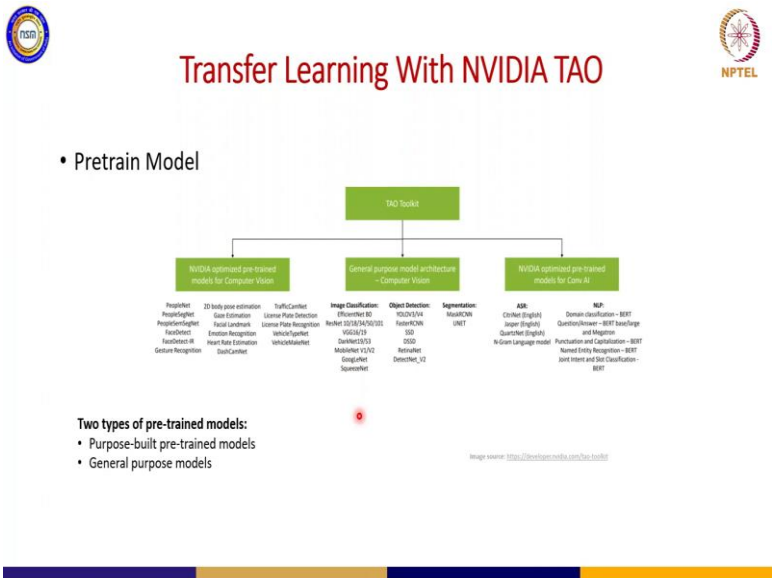

So, what are the pretrained model that exist are on NVIDIA TAO, we have 2 types of pre trained model that exist there we have the one called purpose built Pretrained Model. Now this pre trained model they are built for you to use on the go.

You may not even need to supply your neural data they are just built for a particular purpose. Example is the PeopleNet this model recognize persons there is also the 2D pose estimation it recognizes human pose estimation, there is a license plate detection license plate recognition all of these exists. Also it does exist in the NLP domain as well where you have the BERT you have megatron and the likes are there.

And the second one is the general purpose model that is this general purpose model you can bring in your own data your new data to in for your own specific tasks you can use those model for to achieve that purpose. So, and under that we have 3 categories which are image classification, object detection and segmentation.

So, for under image classification you have the EfficientNet which is there very popular, there is the RestNet 10/18/34/50/101 layers there is the VGG 16 and 19 the DarkNet which was used for Yolo the MobileNet GoogLeNnet and the likes they are there as well.

So, for object detection there is a YOLOV4, YOLOV3, faster RCNN and for segmentation you have the maskRCNN and UNet. So, you can pick this Pre trained

model and take your new data and supply it to this pre trained model and train using that Pre trained model to train your data then you can now have your new model and make use of it.

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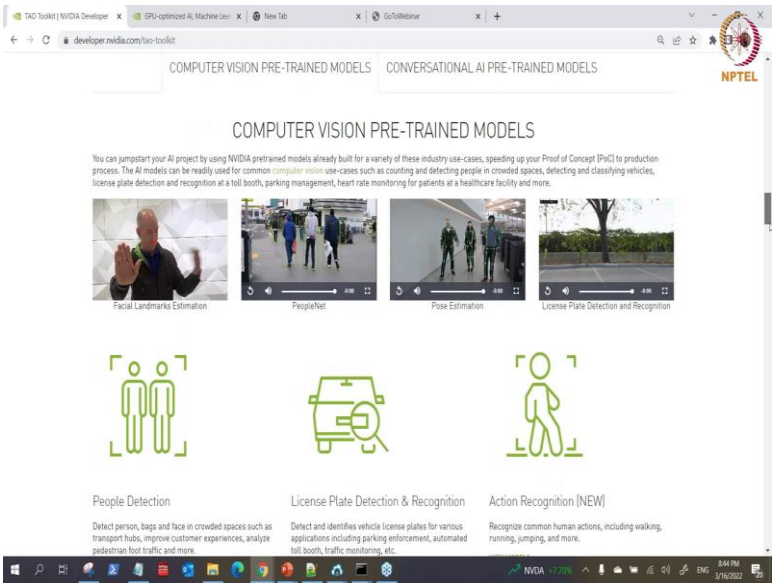

So, examples are what you can see here I will play this you can see.

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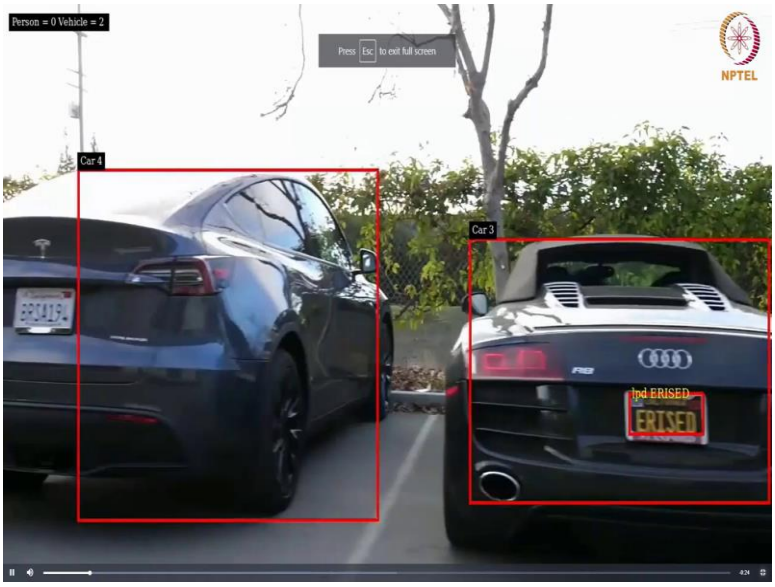

So, this is you can see its recognizing the plate number.

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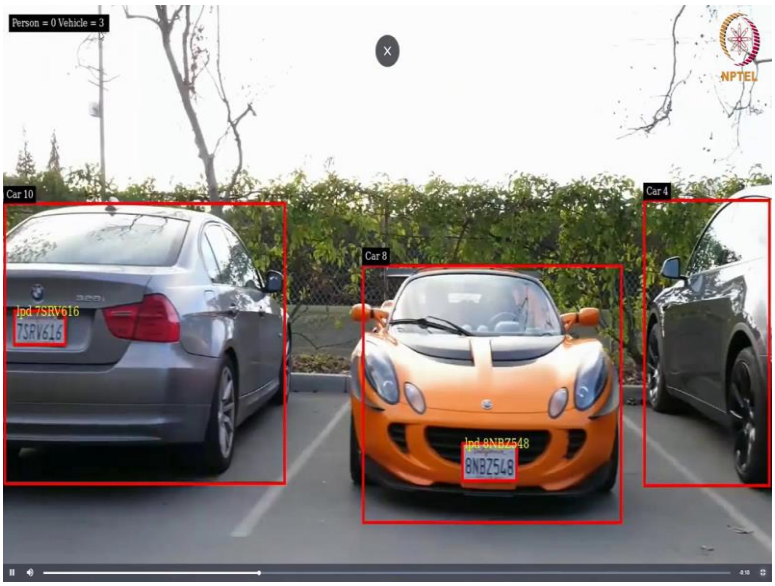

That is a car it show you how many vehicles are on the screen 0 present.

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This plate number and you can also recognize what the number on the plate's number as well. So, this are general purpose I mean these are specific purpose model which you can use specifically for license plate, probably somebody who is working on the toll gate. So, this can be used deployed for a toll gate use.

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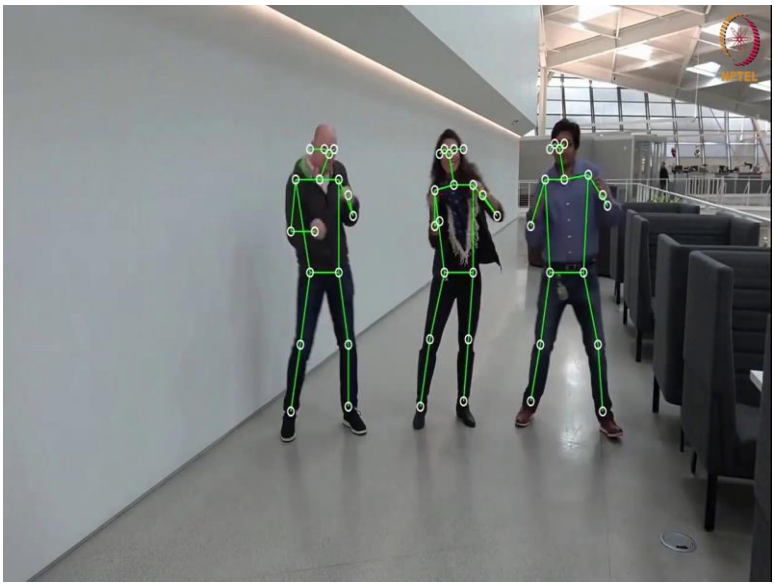

There is also what we call the image pose estimation. So, this one they can use it for action recognition actual recognition that what is that person doing is it dancing, is it the person is it jumping or is it picking something there. So, they can use this as well for that and there is the PeopleNet which I talked about as well.

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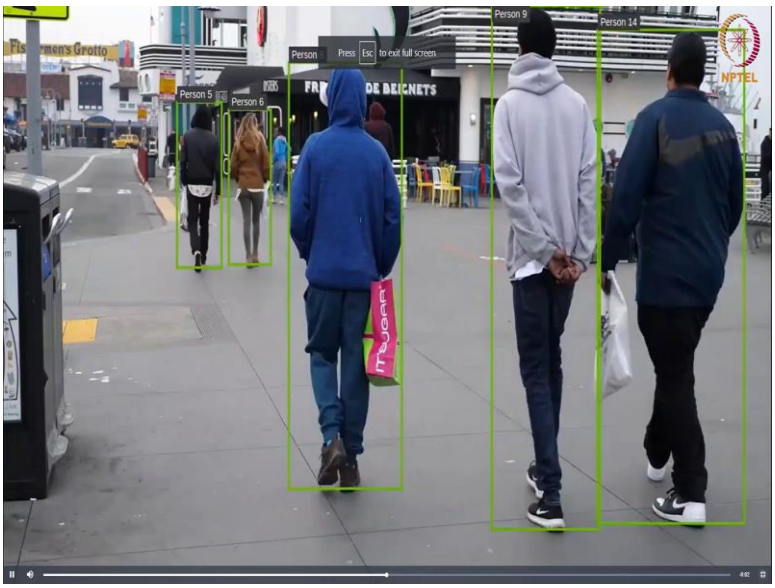

So, it recognizes women that is a person and is counting them as well.

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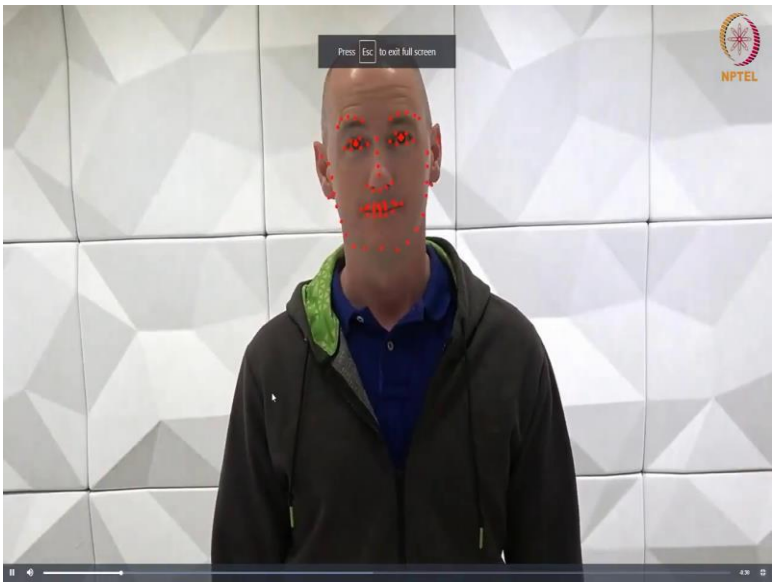

Then we also have what we call the face marks estimation as well.

So, it can grab your face it is like a focus, where if you turn to the other side or any side it can get the features of your of your face there. So, there are many of them that exist.

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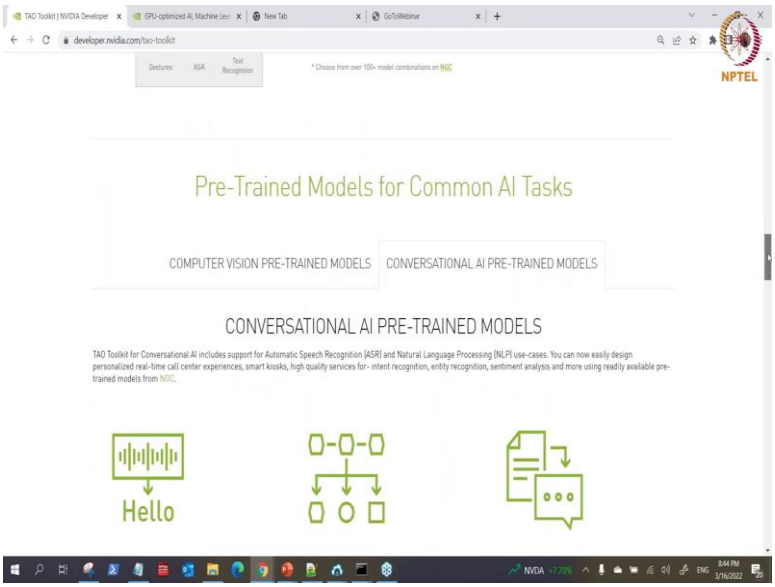

They are also in the conversational AI Domain as well there are many pretrained model.

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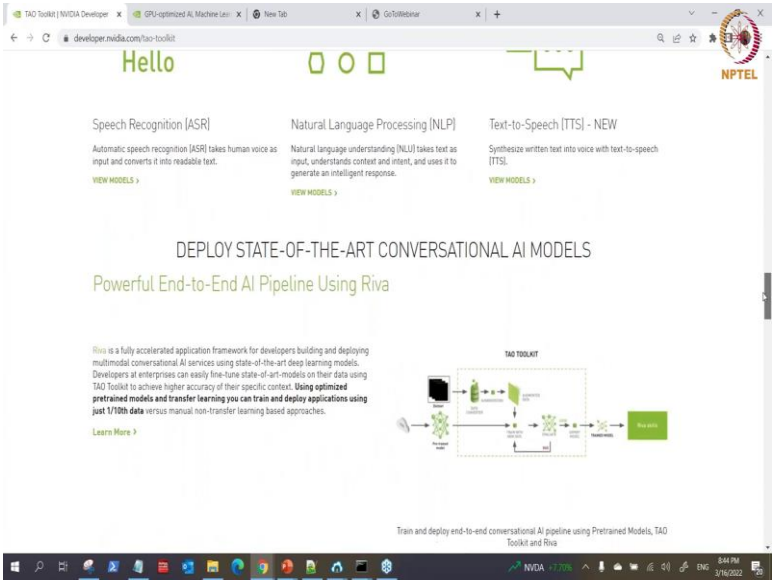

Which you can see with NVIDIA TAO there is also text to speech natural language on that you can see these models are already there.

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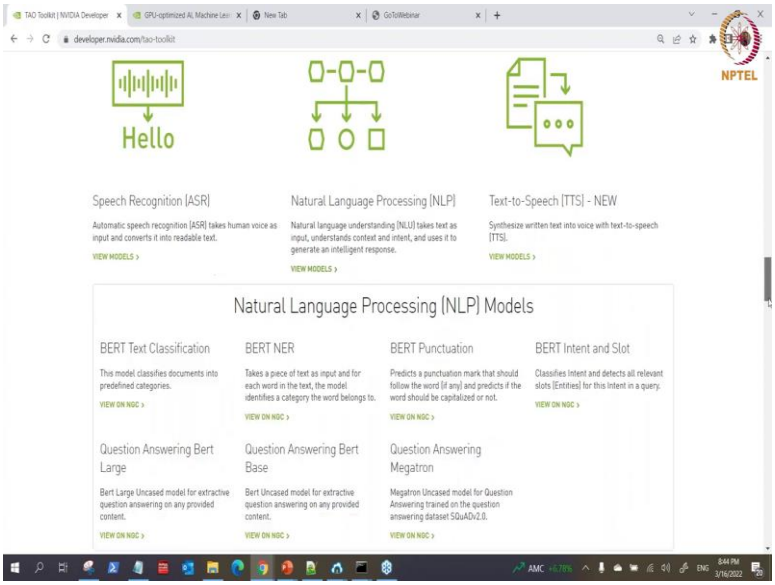

BERT for test classification penetration and the likes there are so many of them that those exist.

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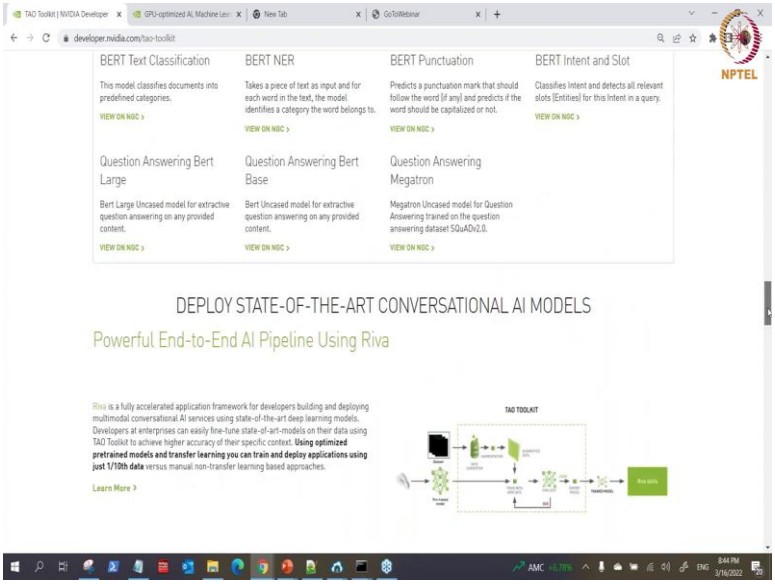

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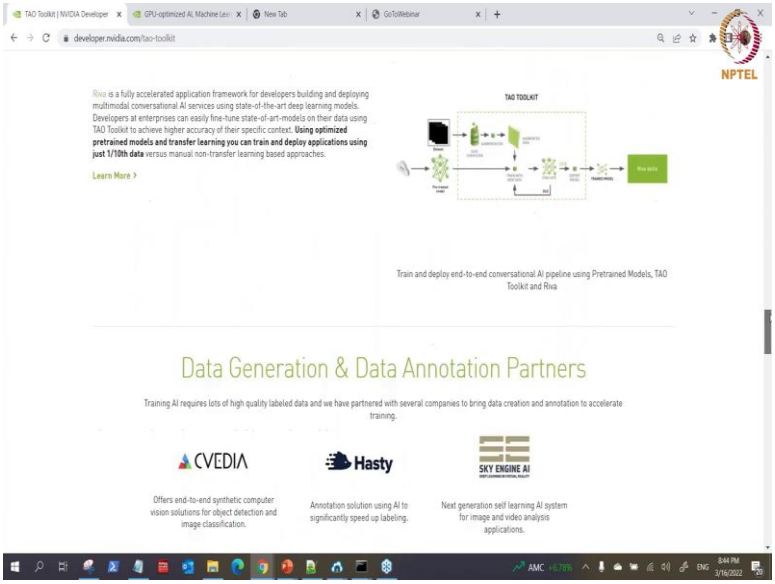

So, we are back here.

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So, let me talk about the overview of the TAO to with respect to computer vision. So, what happened is that you have your data here your raw data so you need to process the data convert it to a particular format. If you want to use transfer learning, so using transfer learning you need a pre trained model for you to be able to use a pre trained model. You must have full details the know-how of the pre trained model what kind of data what is the dimension of data it can accept, what is the format of the data you can accept.

So, you do that here you convert your data augment your data and everything goes into train and where does it train you bring in your world, your pre trained model elsewhere. So, then you train using the pre trained model. So, when you train you evaluate your training results, if it is bad you have to train go back and train and then if it is good you proceed to prune.

Now, pruning is a level of optimization such that it reduces the size of your model and when it reduce the size of your model your model doing inferencing your model will be faster that is the purpose of that it will be faster. But there is a detriment to that it says that because its prune your model your model the accuracy is then to drop a little bit. So, what happened is that after you prune it is advisable to retrain again.

So, that you can get back your accuracy while you have the benefit of small size model with faster inferencing. So, you retrain after you retrain you evaluate the training if the

training the result you are getting is not good as before you prune you go back again and re train. If he result is ok is good then you can export your model and use it forever or whatever you want to use.

And along the line you can also do what we call INT8 calibrations which is also a form of optimization to make your model also run faster. So, this is all what I have explained I have showed you before about those AI Model that are ready you can use.

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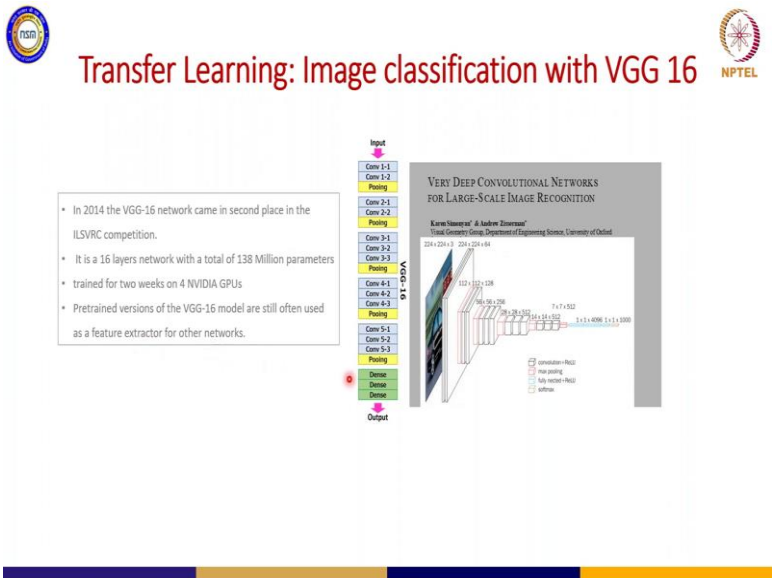

Now, transfer learning I just want to show you some examples of those model which we us in transfer learning for image classification there is what called the VGG 16 and there is also VGG 19.

So, this model is good for feature extraction. So, people they usually use it in all that big models as well, you can see it can serve as a backbone for some other models you the essence is that if you are dealing with a task that need future extraction. So, this is good to work to help you extract our futures.

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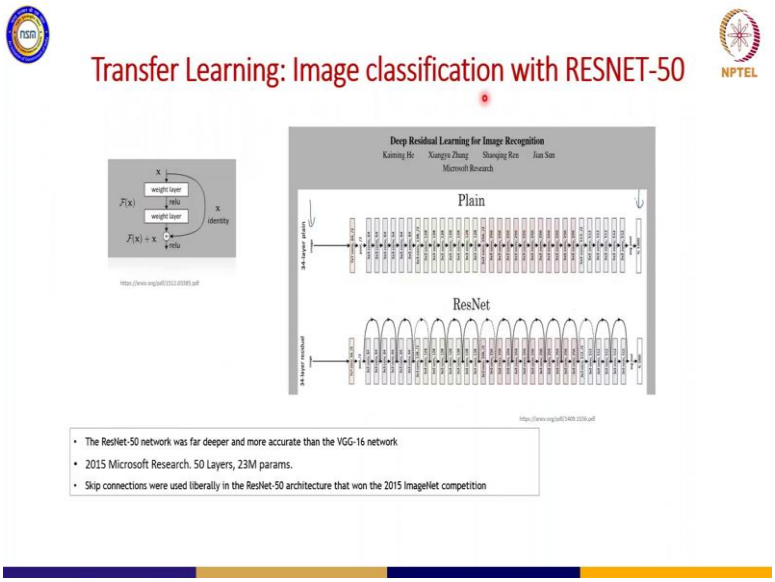

There is also the RESNET this model this consists of 50 layers the RESNET 50 we have RESNET 50 we have RESNET 18 we have RESNET 34. So, this is example RESENT 50 it makes use of skip connections that is what it makes use of skips connections and it perform better in terms of future attraction than VGG 16.

So, you can also look this hub because this is important, because before you can use this type of model you need to understand the flow out the data format like I have explained before and how the model works internally.

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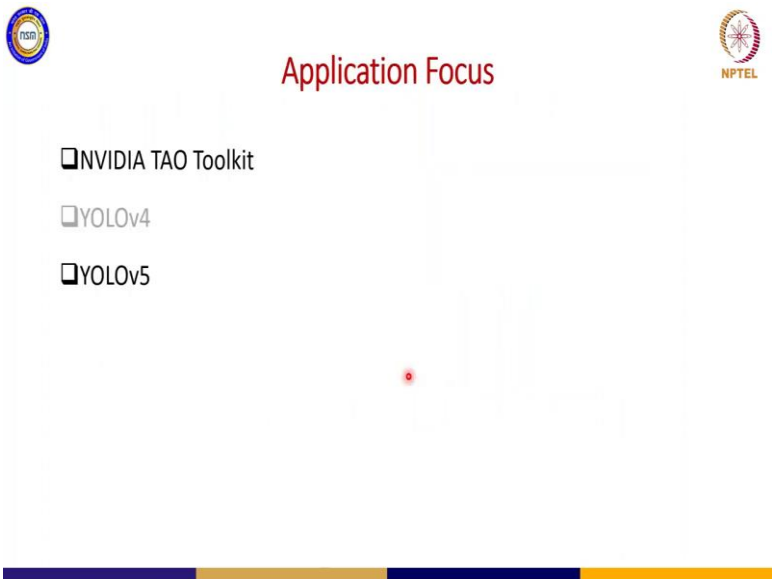

So, our application focus for today so as not to waste time will be NVIDIA TAO tool kit there is also YOLO v4 there is YOLO v5 we do not know if there is not we might not be able to cover YOLO v 4, but I would try as much as possible to also to cover YOLO v5.

But YOLO v5 we want to cover computer vision here now with NVIDIA TAO tool kit we want to cover image classification. So, with this object for YOLO v5 for computer vision for object detection because we might not be able to use camera direct because I am doing using SSH. Let us see how it goes? But we will finally way around that one.

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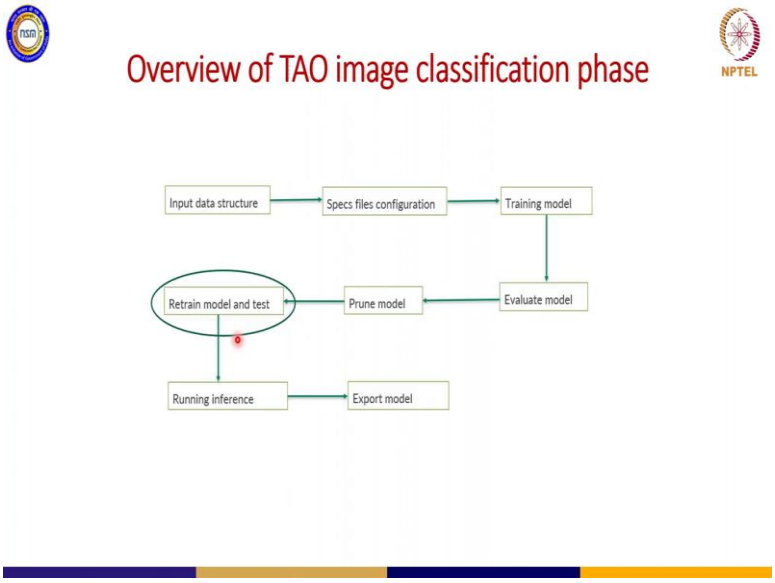

So, let us proceed now overview of tao image classification phase. So, if you want to use NVIDIA TAO for your transfer learning to achieve image classification tasks the first thing you need to do is to work to check your input data structure. So, what I mean by this is your data format rather that ok. You must have a particular pretrained model in mind you want to use let us say for example RESNET so you must know ok.

Now, the data my raw data that I want to use it must be in the particular format which RESNET can which can serve as input into RESNET model. So, you consider that after that there is what we call the specs file that is the configuration file, that configuration file is for the pre trained model you have to configure it to suit your new data that you your new data that you are working on you have to configure it to suit that.

So, there are phases in that I we explain into details as we proceed then after you configure your specification file, then you start training your model. After training your model you can proceed to evaluate the model and when you evaluate the model you can prune the model which I have explained before. So, while you prune the model the size is reduced, then you need to retrain if there is an accuracy loss while you prune the model you retrain and test. When you retrain and test you check the accuracy.

If the accuracy is not satisfactory you keep retraining and when it is satisfactory you proceed to inferencing. So, you inference you run your inference and when the inference is good you can now export your model and use it for what you tend to use it for.

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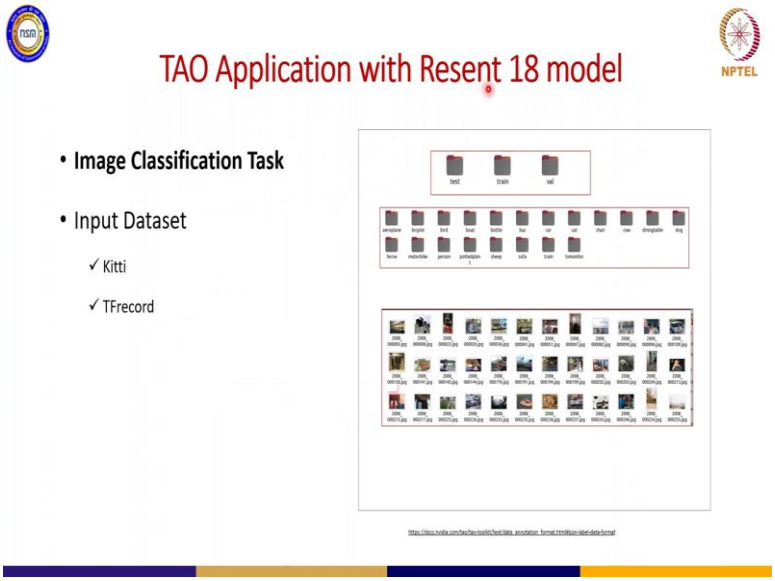

So, let us consider the case of RESNET 18 that we want to use RESNET 18 format so RESNET 18. So, how do you do that now?

Now, first of all you prepare your data set let us say this is our data set we have it already it is and we have splitted it into test train and validation that they are all inside our images. So, want to do image classification. So, in each of these folder where you have test what you will have inside is the folder consisting of the image and the class. So, the image will be inside for example for bus all what would be here were images of bus then you your name the folder with the name of the class. So, each folder consists of distinct images not mixture; distinct images.

So for example, if we take image of a person for example, what we see there is just persons like this. So, what is inside each of these for aeroplane the image that will be there will just be aeroplane, for bicycle the images that will be there we just bicycle and all that. Then if you now want to go for that to do maybe for computer vision then your data set has to be in this format Kitti format or TF record format. But we are just doing we will be dealing with just image classification.

So, data will just look exactly this way which is just JPG and we arrange them in terms of their classes in folder and we have the version of tests, train and validation.

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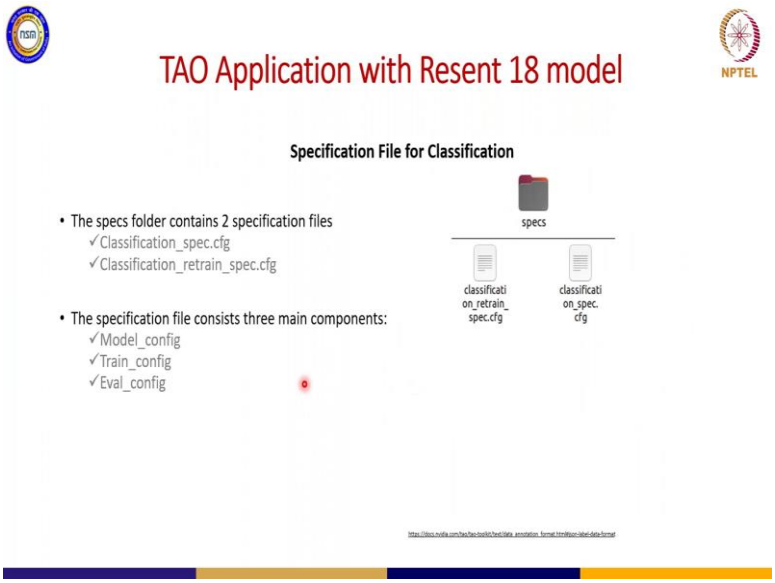

So, the specification file specs there is a folder called spec. So, that spec that folder spec consists of 2 files there is the classification spec and also classification retrain spec. So, when you want to train you will use the word the classification spec to train you configure that one for the training. So, after you train and when you tend to prune after your pruning you want to retrain, then you use this for classification retrain spec is what you will use.

Now, for each of these they are divided into they are 3 segments inside of each of these. So, the first segment is the Model configuration, Train configuration and Evaluation configuration that are there. So, I will show you the internal structure now.

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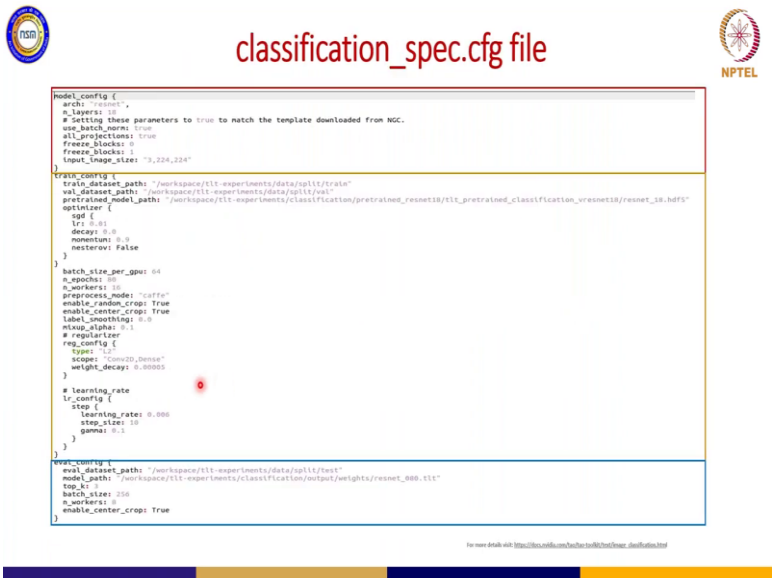

So, this is the classification-spec.cfg file. So, this file what happens here is used for training. So, inside it you have the model config you have the train config and you have the evaluation config.

So, for the model config you specify the architect the architecture you want to use which is what we specified that is RESNET we want to use pre trained model pre rained model will be RESNET of what type 18 layers we want to use so the image ok. what is the input size? So, the input size for RESNET the dimension will be what you see three by 2 24 by 224.

Then we proceed to the configuration the train configuration. So, where would you get access to your trained data set? So, this is train_dataset_path. So, you have to specify the path where your data is and also your validation data path this is val_dataset_path. Where it is? And then your pre trained model the model you want to use to train this is our RESNET you specify the path as well. So, it is save as what resnet_18.hdf5.

Then you look at it ok the batch size per GPU, then the number of epochs which is what 80 you set that then the learning rates also you set that, then when you for the evaluation also the paths of your data set your evaluation data set that is the test data. So, you set the path as well like what we are seeing here, then the model path that is after you finish training where to save it. So, that I can use it for the evaluation you set the path as well because the model will be safe in output, so you set the path as well and all that. And so

there are details about all of the features here, but I am just telling you the default ones which.

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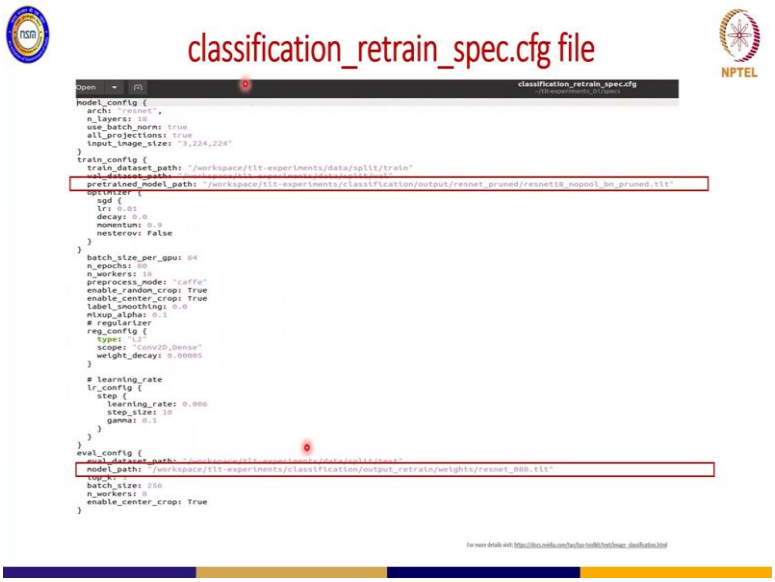

Then this is now the classification retrained specification file. So, it is similar to the classifications specification file that is the one we use for training. So, the only difference that you have there is the pretrained model paths, that is when you pretrained when you when your model has been trained and when it has been pruned. So, where are you going to get the model to be retrained?

So, you specify the path this way it is also there I will show you the for that structure. So, that you do not get confused also when you want to evaluate as well this is the path. So, you set all these paths these are path that are on your systems. So, it is not compulsory that it must be what you are seeing here exactly. So, it is based on your folder structure on your personal laptop or workstation that you have.

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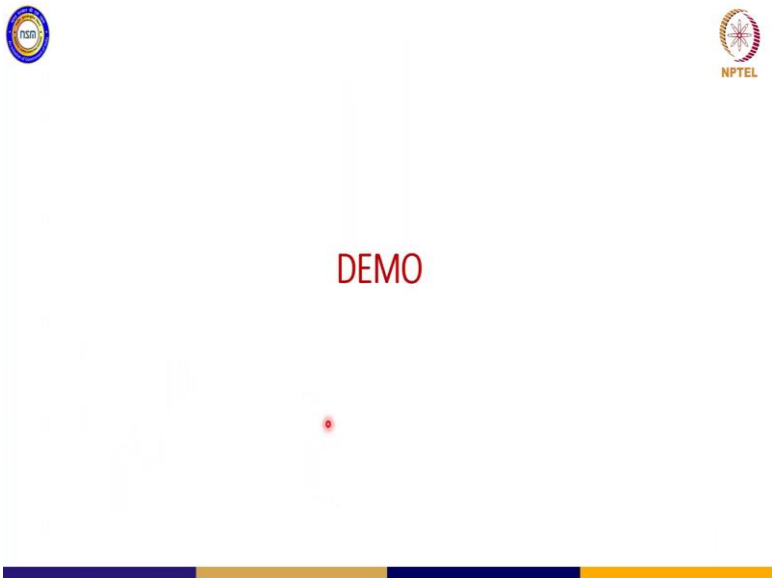

So, quickly let us jump into a demo for that. So, that we know what we can do about that.

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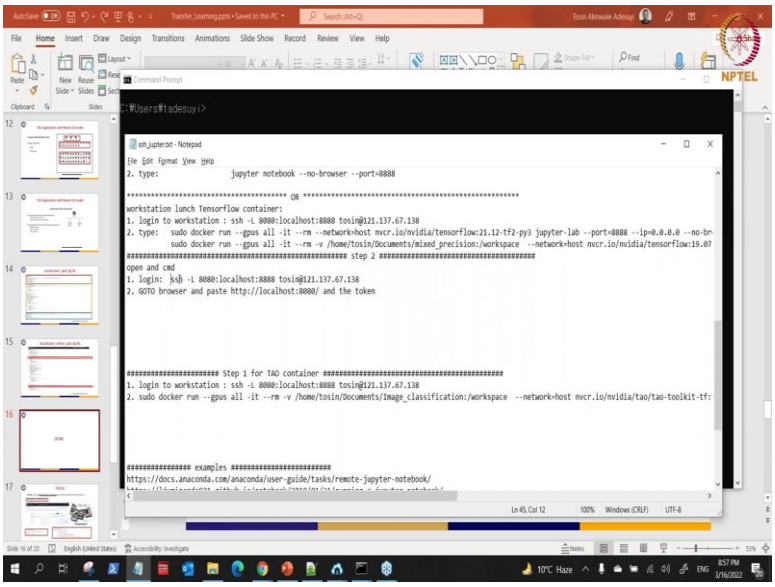

So, what I would do now is I have to connect through my I have to connect to my workstation ok.

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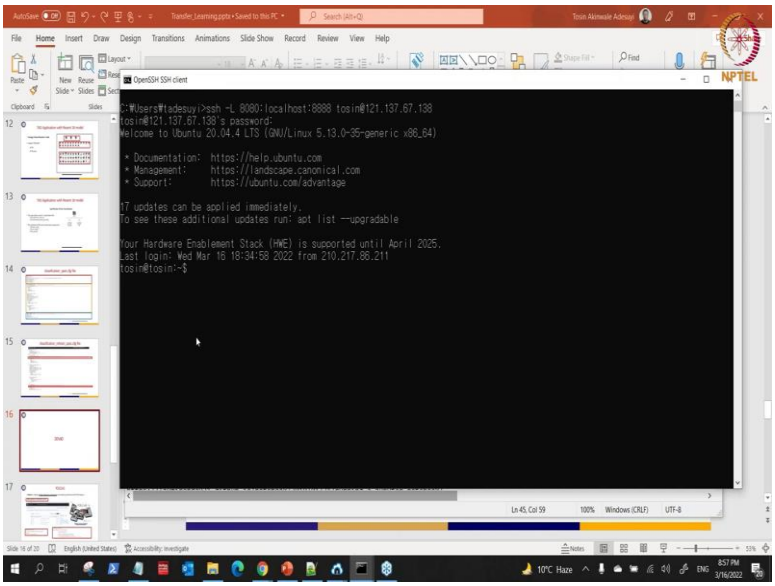

SSH connect to my workstation ok good connected now. So, the next thing to do is to so before you can use the NVIDIA TAO for your transfer learning you need to pull the container.

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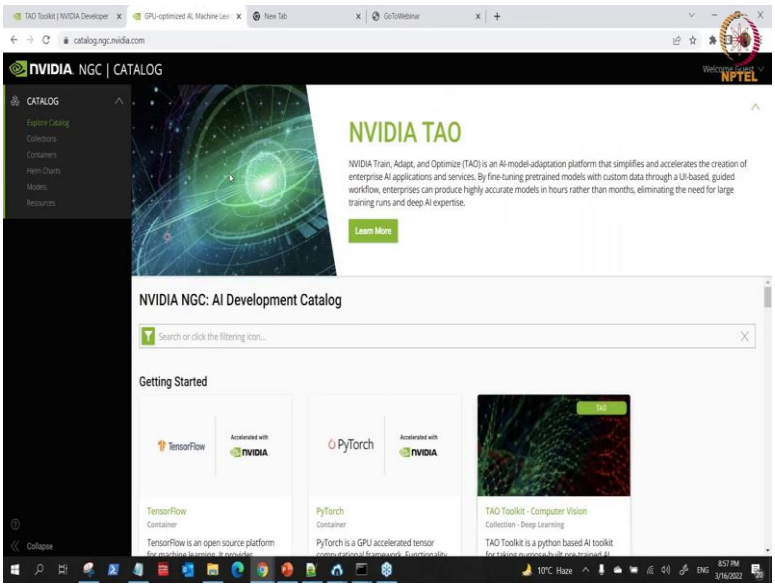
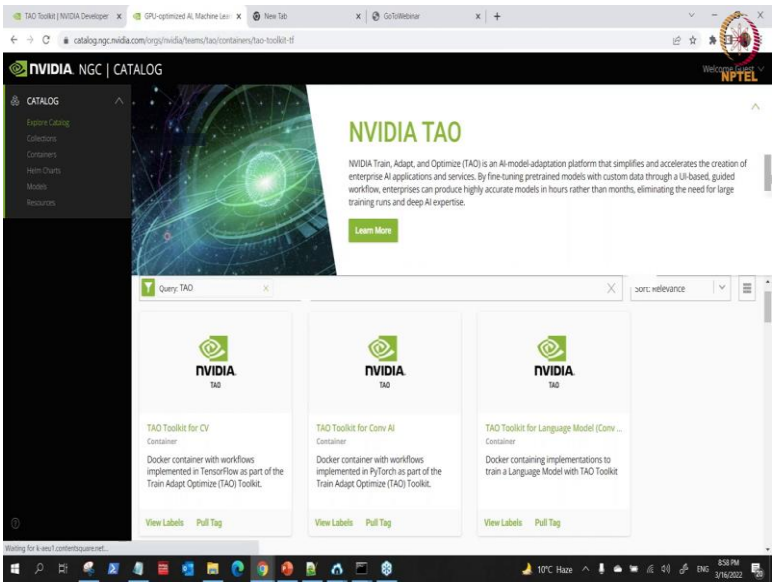


So, let me show you where you can pull the container here. So, you come to this place this is the catalogue dot NGC like I show in the last image dot NVIDIA dot com.

(Refer Slide Time: 25:24)



So, when you get a so what you do is you click you search you can search just type TAO and when you type on TAO you can see this is. If you can see what is here this is TAO toolkit for CV, CV means computer vision.

So, there is another TAO for conversational AI that is what you want to deal with. So, what we are dealing with here is this.

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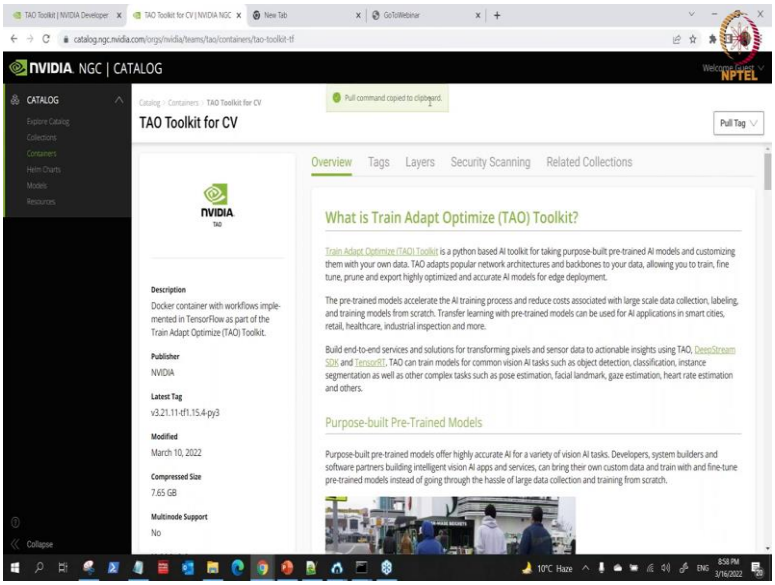
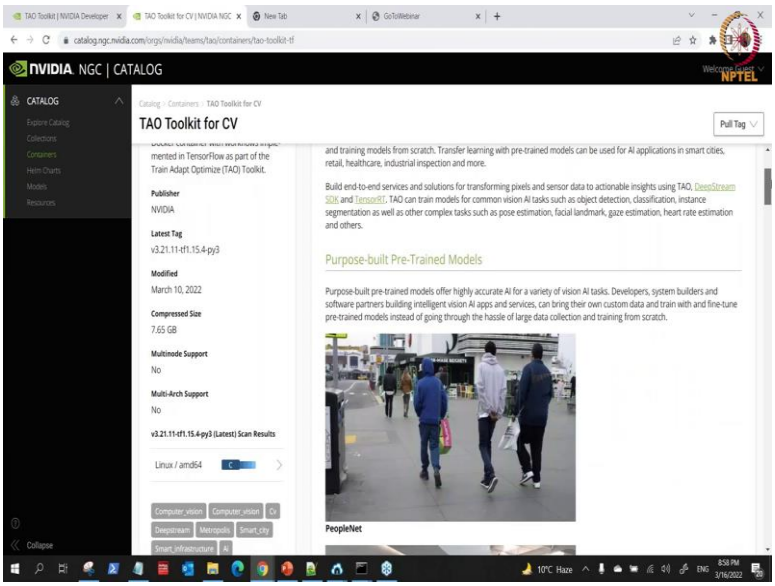


So, we go then these are details that you can read.

(Refer Slide Time: 25:49)



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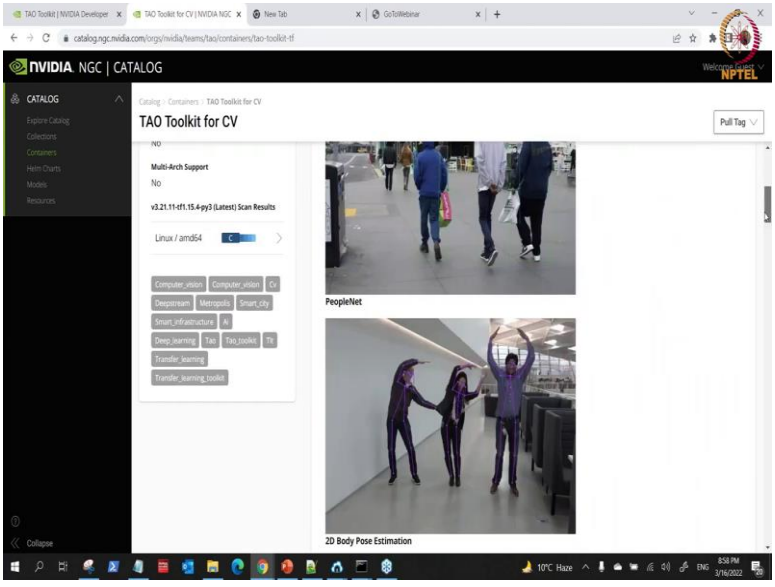

About it and you see what it can do.

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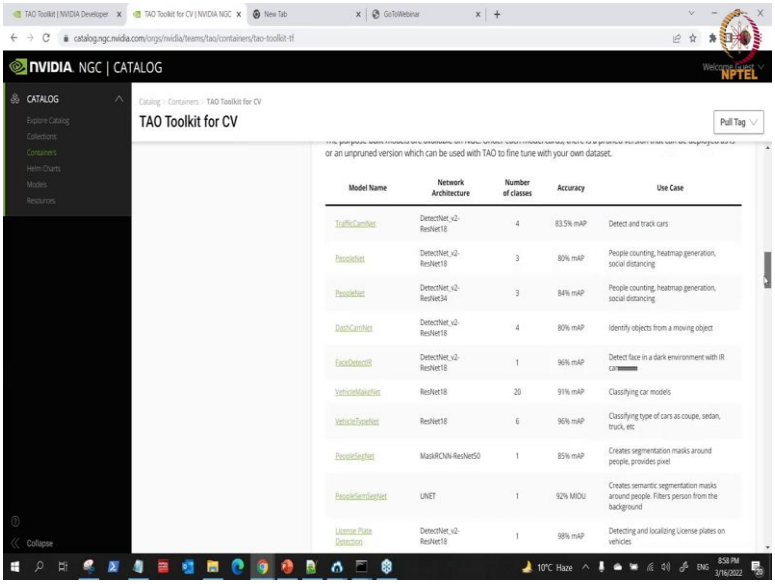
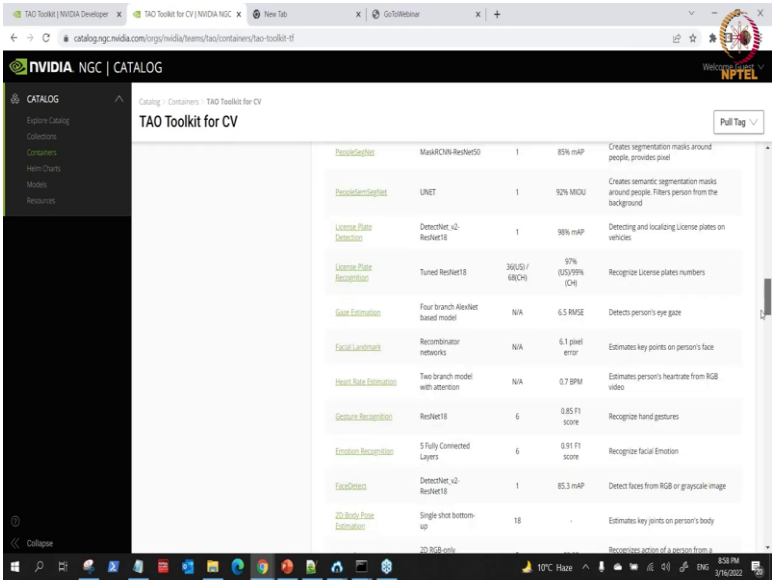


(Refer Slide Time: 25:55)



So, and this are the list of all the models that are inside the TAO up there.

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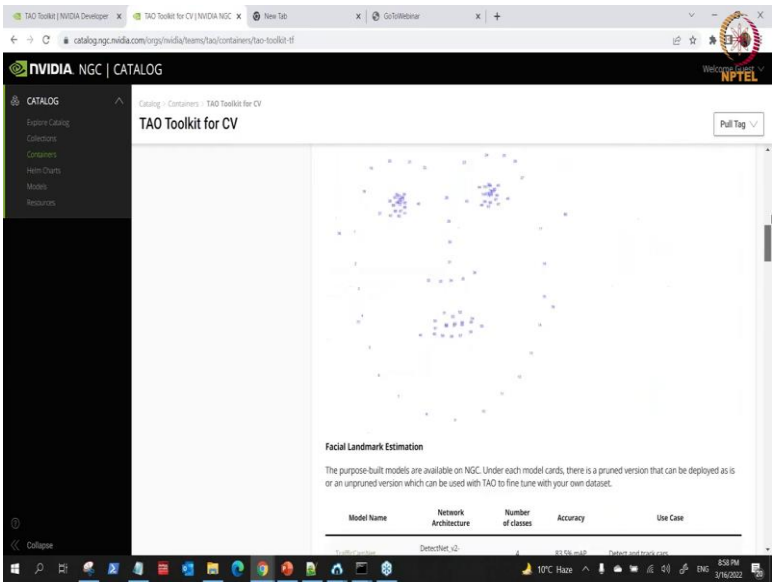
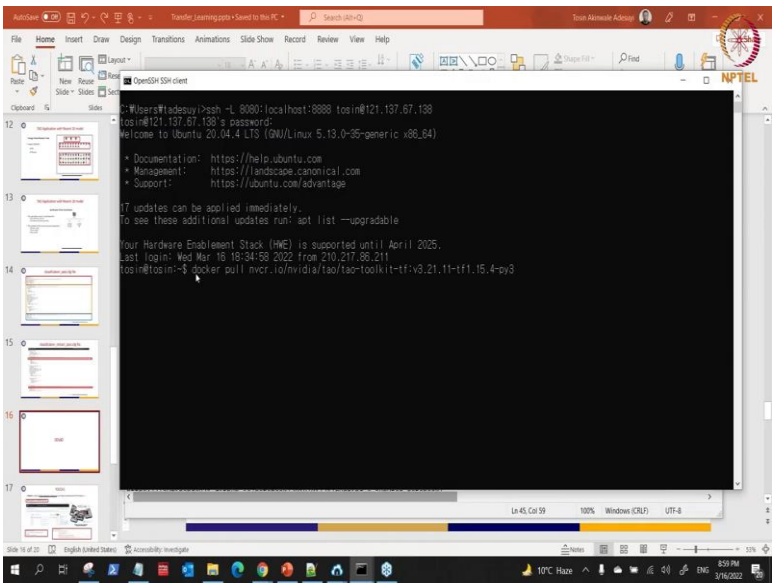


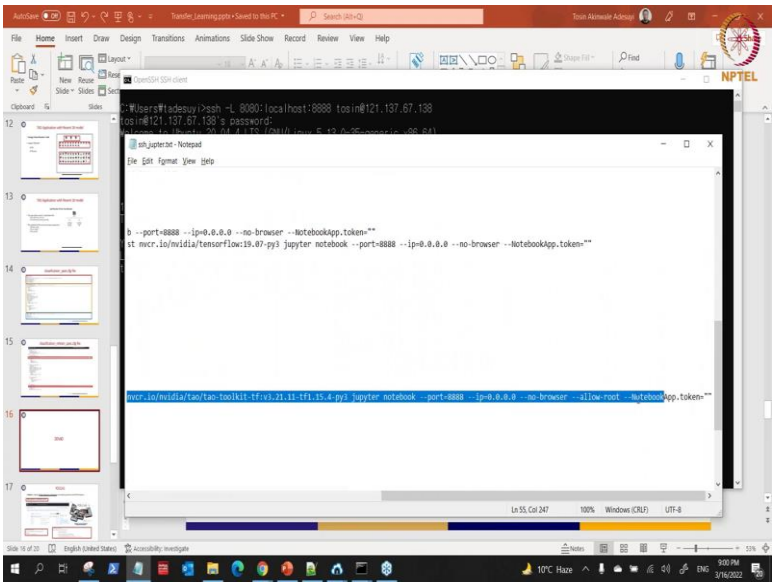
So, you come to this place you click on this tag it will come down. So, you select one of them. So, if I select this you can see command is pulled up.

(Refer Slide Time: 26:18)



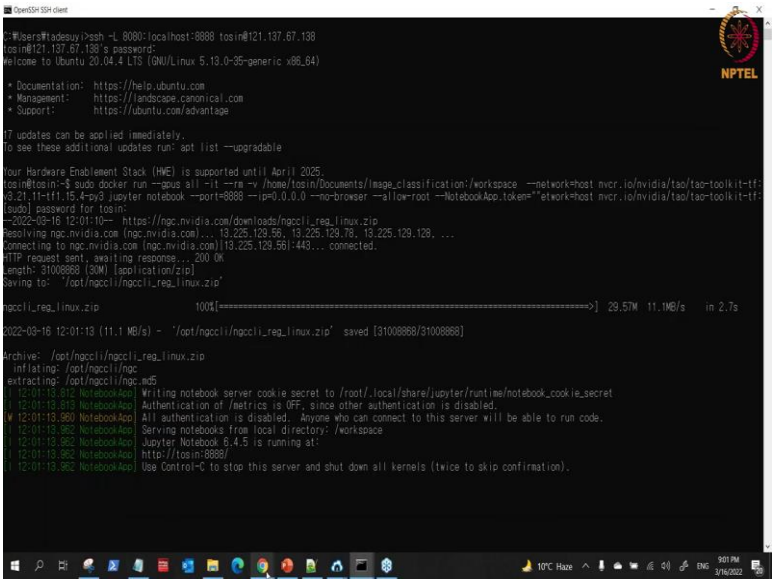
So, you can now go back to and you can come here and say docker pull this I have already pulled this already I have done that. So, once you pull this container then next thing to do is to what is to run the container you run the container. So, you do not need to cram anything here everything is explanatory, let me see you can also install them somewhere. So, that you do not because they are very long I must say.

(Refer Slide Time: 26:55)



So, I will explain this part to you will explain the parts coming with..

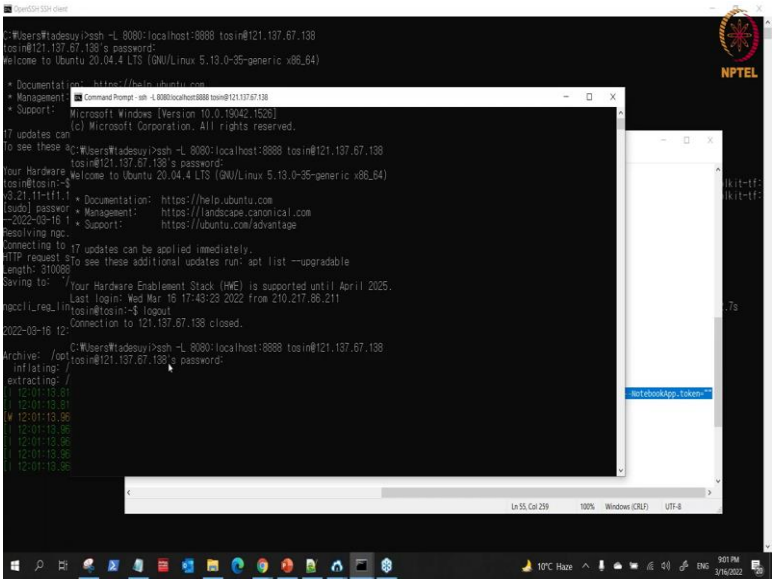
(Refer Slide Time: 27:26)



So, I come here then I paste it here let me expand this what I have here. So, what you can see here is that ok. So, this is pseudo docker you can run the GPU all this use all the GPU that are available, then make it in interactive mode you remove it when you are not in use this is my project work part. What I will be using this is the path for my projects that are mapping it into the workspace this a folder inside the container.

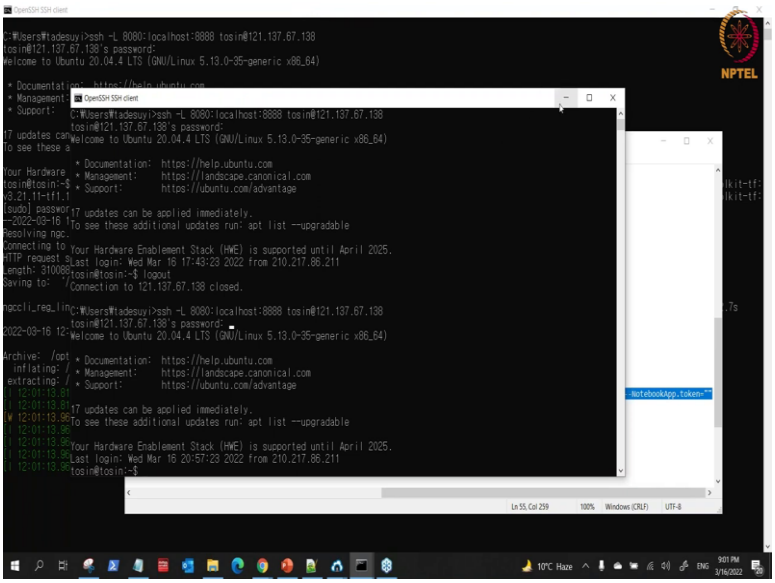
And I am calling the container here what you can see this is the name of the container to be launched inside a, we launch inside the notebook with these ports. So, once I run that see so it is going on and so yes the notebook is running out. So, what I need to do next is.

(Refer Slide Time: 28:41)



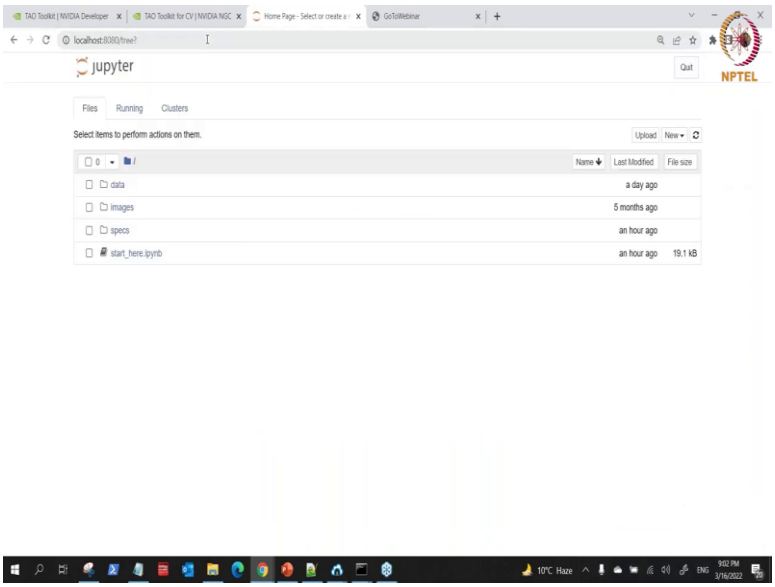
Because I am connecting remote leaders while I am doing all this configuration for your own personal system, you might not need to go do this long go too long this way.

(Refer Slide Time: 28:56)



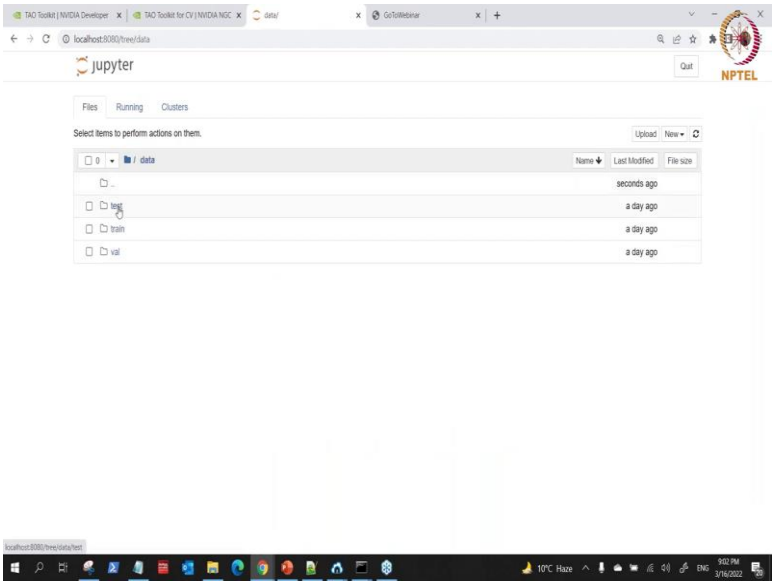
So, if you are working directly on your workstation you do not need to do this part. So, what happen is after you have launched your container like this so you just go to your browser.

(Refer Slide Time: 29:15)



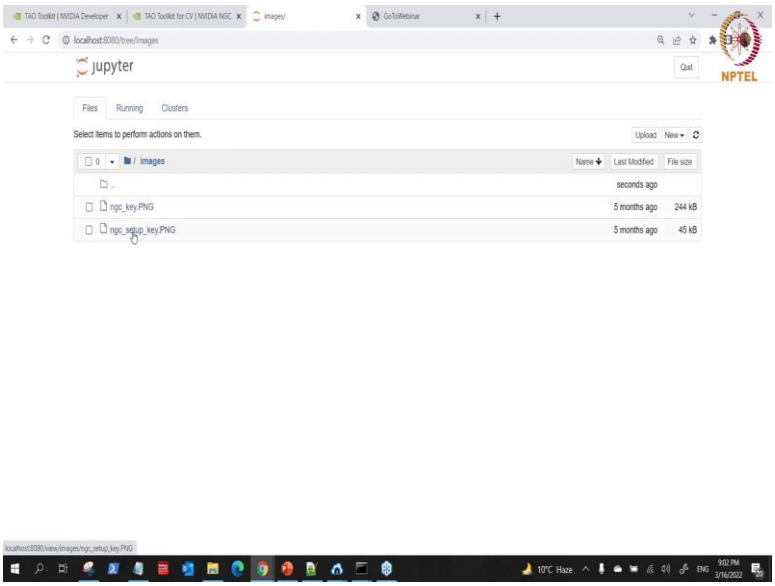
So, you go to your browser then you next thing you do is what you just say local host and this and it will run. So, this is the project path. So, what I have here is my data.

(Refer Slide Time: 29:23)



This is the data I told you to test val train and validation these images there is nothing there is just an image that I used to for this notebook.

(Refer Slide Time: 29:35)



That is what is there it is not a paths of the project. So, it is just what I use for this notebook.

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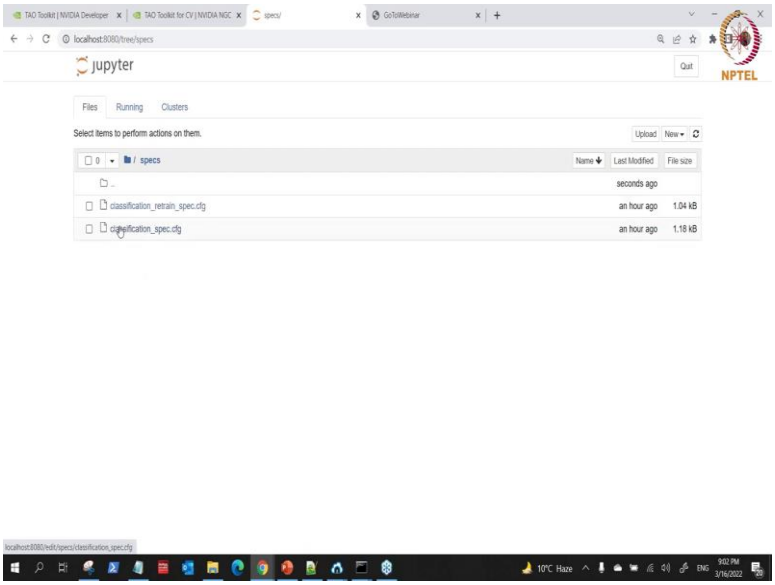

Then there is a specification file which I told you this is the one for training and this is the one for retraining.

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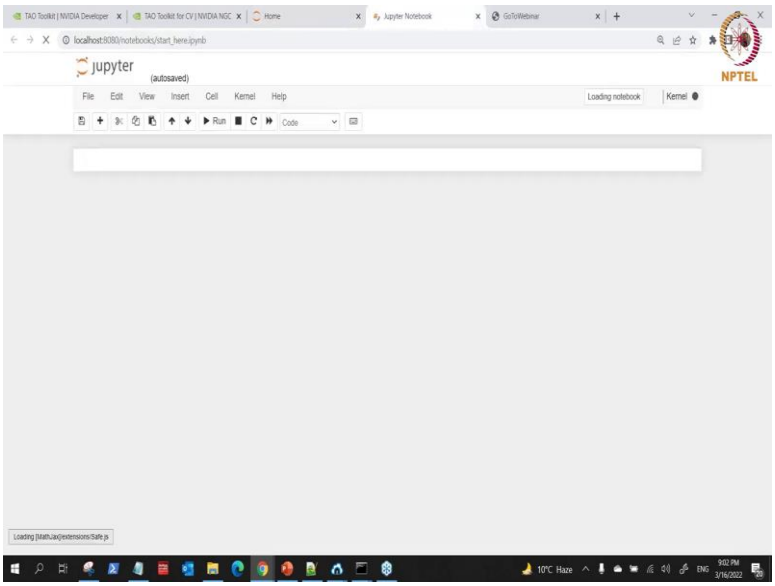

So, we get back here and what click on this is our notebook.