Back **Autonomous Driving (Case Study)**
Graded Quiz • 1h 15m

Due Sep 25, 11:59 PM +03

Congratulations! You passed!

Grade received 80% **Latest Submission Grade** 80% **To pass** 80% or higher

Go to next item

1. To help you practice strategies for machine learning, this week we'll present another scenario and ask how you would act. We think this "simulator" of working in a machine learning project will give a task of what leading a machine learning project could be like!

1 / 1 point

You are employed by a startup building self-driving cars. You are in charge of detecting road signs (stop sign, pedestrian crossing sign, construction ahead sign) and traffic signals (red and green lights) in images. The goal is to recognize which of these objects appear in each image. As an example, the above image contains a pedestrian crossing sign and red traffic lights

$$y^{(i)} = \left[\begin{array}{c}0\\1\\0\\1\\0\end{array}\right]\begin{array}{l}\text{“stop sign”}\\\text{“pedestrian crossing sign”}\\\text{“construction ahead sign”}\\\text{“red traffic light”}\\\text{“green traffic light”}\end{array}$$

Your 100,000 labeled images are taken using the front-facing camera of your car. This is also the distribution of data you care most about doing well on. You think you might be able to get a much larger dataset off the internet, that could be helpful for training even if the distribution of internet data is not the same.

You are just getting started on this project. What is the first thing you do? Assume each of the steps below would take about an equal amount of time (a few days).

- Spend a few days checking what is human-level performance for these tasks so that you can get an accurate estimate of Bayes error.
- Spend a few days training a basic model and see what mistakes it makes.
- Spend a few days collecting more data using the front-facing camera of your car, to better understand how much data per unit time you can collect.
- Spend a few days getting the internet data, so that you understand better what data is available.

Expand

Correct
As discussed in lecture, applied ML is a highly iterative process. If you train a basic model and carry out error analysis (see what mistakes it makes) it will help point you in more promising directions.

2. Your goal is to detect road signs (stop sign, pedestrian crossing sign, construction ahead sign) and traffic signals (red and green lights) in images. The goal is to recognize which of these objects appear in each image. You plan to use a deep neural network with ReLU units in the hidden layers. For the output layer, which of the following gives you the most appropriate activation function?

1 / 1 point

- Sigmoid
- Linear

ReLU

Softmax

Expand

Correct
Correct. This works well since the output would be valued between 0 and 1 which represents the probability that one of the possibilities is present in an image.

3. You are carrying out error analysis and counting up what errors the algorithm makes. Which of these datasets do you think you should manually go through and carefully examine, one image at a time?

1 / 1 point

- (selected) 500 images on which the algorithm made a mistake
- 500 randomly chosen images
- 10,000 images on which the algorithm made a mistake
- 10,000 randomly chosen images

Expand

Correct
Focus on images that the algorithm got wrong. Also, 500 is enough to give you a good initial sense of the error statistics. There's probably no need to look at 10,000, which will take a long time.

4. After working on the data for several weeks, your team ends up with the following data:

1 / 1 point

- 100,000 labeled images taken using the front-facing camera of your car.
- 900,000 labeled images of roads downloaded from the internet.
- Each image's labels precisely indicate the presence of any specific road signs and traffic signals or combinations of them. For example, $y^{(i)} = \begin{bmatrix} 1 \\ 0 \\ 0 \\ 1 \\ 0 \end{bmatrix}$ means the image contains a stop sign and a red traffic light.

When using a non fully labeled image such as $y^{(i)} = \begin{bmatrix} 0 \\ ? \\ 1 \\ ? \\ 1 \end{bmatrix}$, which of the following strategies is most appropriate to calculate the loss function to train as a multi-task learning problem?

- Make the missing entries equal to 0.
- It is not possible to use non fully labeled images if we train as a multi-task learning problem.
- Make the missing entries equal to 1.
- (selected) Calculate the loss as

Loading [MathJax]/jax/output/CommonHTML/jax.js

Expand

Correct

Correct. We can't use the components of the labels that are missing but we can use the ones we have to train the model.

5. The distribution of data you care about contains images from your car's front-facing camera, which comes from a different distribution than the images you were able to find and download off the internet. Which of the following are true about the train/dev/test split?

1 / 1 point

- [ ] The dev and test sets must contain some images from the internet.
- [ ] The train, dev, and test must come from the same distribution.
- [x] The dev and test sets must come from the same distribution.

  Correct

  Correct. This is required to aim the target where we want to be.

- [x] The dev and test set must come from the front-facing camera.

  Correct

  Correct. This is the distribution we care about most, thus we should use this as a target.

Expand

Correct

Great, you got all the right answers.

6. Assume you've finally chosen the following split between the data:

0 / 1 point

Dataset:	**Contains:**	**Error of the algorithm:**
Training	940,000 images randomly picked from (900,000 internet images + 60,000 car's front-facing camera images)	12%
Training-Dev	20,000 images randomly picked from (900,000 internet images + 60,000 car's front-facing camera images)	15.1%
Dev	20,000 images from your car's front-facing camera	12.6%
Test	20,000 images from the car's front-facing camera	15.8%

You also know that human-level error on the road sign and traffic signals classification task is around 0.5%. Which of the following is True?

- ( ) You have a high variance problem.
- ( ) You have a large data-mismatch problem.
- ( ) You have a high bias.
- (•) You have a too low avoidable bias.

Expand

Incorrect
On the contrary, the avoidable bias is very high.

7. Assume you've finally chosen the following split between the data:

1 / 1 point

Dataset:	Contains:	Error of the algorithm:
Training	940,000 images randomly picked from (900,000 internet images + 60,000 car's front-facing camera images)	8.8%
Training-Dev	20,000 images randomly picked from (900,000 internet images + 60,000 car's front-facing camera images)	9.1%
Dev	20,000 images from your car's front-facing camera	14.3%
Test	20,000 images from the car's front-facing camera	14.8%

You also know that human-level error on the road sign and traffic signals classification task is around 0.5%. Based on the information given, a friend thinks that the training data distribution is much easier than the dev/test distribution. What do you think?

- ○ Your friend is wrong. (I.e., Bayes error for the training data distribution is probably higher than for the dev/test distribution.)
- ○ Your friend is right. (I.e., Bayes error for the training data distribution is probably lower than for the dev/test distribution.)
- ◉ There's insufficient information to tell if your friend is right or wrong.

Expand

Correct
The algorithm does better on the distribution of data it trained on. But you don't know if it's because it trained on that distribution or if it really is easier. To get a better sense, measure human-level error separately on both distributions.

8. You decide to focus on the dev set and check by hand what the errors are due to. Here is a table summarizing your discoveries:

1 / 1 point

Overall dev set error	15.3%
Errors due to incorrectly labeled data	4.1%
Errors due to foggy pictures	3.0%
Errors due to partially occluded elements.	7.2%
Errors due to other causes	1.0%

In this table, 4.1%, 7.2%, etc. are a fraction of the total dev set (not just examples of your algorithm mislabeled). For example, about 7.2/15.3 = 47% of your errors are due to partially occluded elements.

You shouldn't invest all your efforts to get more images with partially occluded elements since 4.1 + 3.0 + 1.0 = 8.1 > 7.2. True/False?

- ◉ False
- ○ True

Expand

Correct
Correct. These kinds of arguments don't help us to decide on the strategy to follow. Other factors should be used, such as the tradeoff between the cost of getting new images and the improvement of the system performance.

9. You can buy a specially designed windshield wiper that helps wipe off some of the raindrops on the front-facing camera.

1 / 1 point

Overall dev set error	15.3%
Errors due to incorrectly labeled data	4.1%
Errors due to foggy pictures	8.0%
Errors due to rain drops stuck on your car's front-facing camera	2.2%
Errors due to other causes	1.0%

Which of the following statements do you agree with?

- (selected) 2.2% would be a reasonable estimate of the maximum amount this windshield wiper could improve performance.
- 2.2% would be a reasonable estimate of the minimum amount this windshield wiper could improve performance.
- 2.2% would be a reasonable estimate of how much this windshield wiper will improve performance.
- 2.2% would be a reasonable estimate of how much this windshield wiper could worsen performance in the worst case.

Expand

Correct
Yes. You will probably not improve performance by more than 2.2% by solving the raindrops problem. If your dataset was infinitely big, 2.2% would be a perfect estimate of the improvement you can achieve by purchasing a specially designed windshield wiper that removes the raindrops.

10. You decide to use data augmentation to address foggy images. You find 1,000 pictures of fog off the internet, and "add" them to clean images to synthesize foggy days, like this:

0 / 1 point

Which of the following do you agree with?

- If used, the synthetic data should be added to the training/dev/test sets in equal proportions.
- If used, the synthetic data should be added to the training set.

- ( ) With this technique, we duplicate the size of the training set by synthesizing a new foggy image for each image in the training set.
- (•) It is irrelevant how the resulting foggy images are perceived by the human eye, the most important thing is that they are correctly synthesized.

Expand

Incorrect
No. Our objective is to have images that look realistic to the human eye.

11. After working further on the problem, you've decided to correct the incorrectly labeled data. Your team corrects the labels of the wrongly predicted images on the dev set.

0 / 1 point

You have to correct the labels of the test so test and dev sets have the same distribution, but you won't change the labels on the train set because most models are robust enough they don't get severely affected by the difference in distributions. True/False?

- ( ) False, the test set should be changed, but also the train set to keep the same distribution between the train, dev, and test sets.
- ( ) True, as pointed out, we must keep dev and test with the same distribution. And the labels at training should be fixed only in case of a systematic error.
- (•) False, the test set shouldn't be changed since we want to know how the model performs in real data.

Expand

Incorrect
When correcting the labels we are not creating false data we are eliminating unreal data from the set.

12. So far your algorithm only recognizes red and green traffic lights. One of your colleagues in the startup is starting to work on recognizing a yellow traffic light. (Some countries call it an orange light rather than a yellow light; we'll use the US convention of calling it yellow.) Images containing yellow lights are quite rare, and she doesn't have enough data to build a good model. She hopes you can help her out using transfer learning.

1 / 1 point

What do you tell your colleague?

- ( ) If she has (say) 10,000 images of yellow lights, randomly sample 10,000 images from your dataset and put your and her data together. This prevents your dataset from "swamping" the yellow lights dataset.
- ( ) You cannot help her because the distribution of data you have is different from hers, and is also lacking the yellow label.
- (•) She should try using weights pre-trained on your dataset, and fine-tuning further with the yellow-light dataset.
- ( ) Recommend that she try multi-task learning instead of transfer learning using all the data.

Expand

Correct
Yes. You have trained your model on a huge dataset, and she has a small dataset. Although your labels are different, the parameters of your model have been trained to recognize many characteristics of road and traffic images which will be useful for her problem. This is a perfect case for transfer learning, she can start with a model with the same architecture as yours, change what is after the last hidden layer and initialize it with your trained parameters.

13. One of your colleagues at the startup is starting a project to classify stop signs in the road as speed limit signs or not. He has approximately 30,000 examples of each image and 30,000 images without a sign. He thought of using your model and applying transfer learning but then he noticed that you use multi-task learning, hence he can't use your model. True/False?

1 / 1 point

- (●) False
- ( ) True

Expand

Correct
Correct. When using transfer learning we can remove the last layer. That is one of the aspects that is different from a binary classification problem.

14. To recognize a stop sign you use the following approach: First, we localize any traffic sign in an image. After that, we determine if the sign is a stop sign or not. We are using multi-task learning. True/False?

1 / 1 point

- ( ) True
- (●) False

Expand

Correct
Correct. Multi-task learning is about joining several tasks that can benefit from each other.

15. Consider the following two approaches, A and B:

1 / 1 point

· **(A)** Input an image (x) to a neural network and have it directly learn a mapping to make a prediction as to whether there's a red light and/or green light (y).

· **(B)** In this two-step approach, you would first (i) detect the traffic light in the image (if any), then (ii) determine the color of the illuminated lamp in the traffic light.

Approach A tends to be more promising than approach B if you have a ________ (fill in the blank).

- (●) Large training set
- ( ) Problem with a high Bayes error.
- ( ) Large bias problem.
- ( ) Multi-task learning problem.

Expand

Correct

Yes. In many fields, it has been observed that end-to-end learning works better in practice, but requires a large amount of data.