Final Quiz: Autonomous Driving (Case Study)

Congratulations! You passed!

Grade received	Latest Submission Grade	To pass
86.66%	86.67%	80% or higher

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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 you an idea 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, this image contains a pedestrian crossing sign and red traffic lights.

$$y^{(i)} = \begin{bmatrix} 0 \\ 1 \\ 0 \\ 1 \\ 0 \end{bmatrix} \begin{matrix} \text{“stop sign”} \\ \text{“pedestrian crossing sign”} \\ \text{“construction ahead sign”} \\ \text{“red traffic light”} \\ \text{“green traffic light”} \end{matrix}$$

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, which could be helpful for training even if the distribution of internet data is not the same.

Suppose that you came from working with a project for human detection in city parks, so you know that detecting humans in diverse environments can be a difficult problem. 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 collecting more data to determine how hard it will be to include more pedestrians in your dataset.
- ○ Start by solving pedestrian detection, since you already have the experience to do this.
- ○ Leave aside the pedestrian detection, to move faster and then later solve the pedestrian problem alone.
- ◉ Train a basic model and proceed with error analysis.

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, a softmax activation would be a good choice for the output layer because this is a multi-task learning problem. True/False? **1 / 1 point**

- ○ True
- ◉ False

Expand

Correct
Softmax would be a good choice if one and only one of the possibilities (stop sign, speed bump, pedestrian crossing, green light and red light) was present in each image.

3. When trying to determine what strategy to implement to improve the performance of a model, we manually check all images of the training set where the algorithm was successful. True/False? **1 / 1 point**

- ○ True
- ◉ False

Expand

Correct
Correct. This set should be too large to manually check all the images. It is better to focus on the images that the algorithm got wrong from the dev set. Also, choose a large enough subset that we can manually check.

4. After working on the data for several weeks, your team ends up with the following data: **0 / 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.

Because this is a multi-task learning problem, you need to have all your $y^{(i)}$ vectors fully labeled. If one example is equal to $\begin{bmatrix} 0 \\ ? \\ 1 \\ 1 \\ ? \end{bmatrix}$ then the learning algorithm will not be able to use that example. True/False?

- ○ False
- ◉ True

Expand

✗ Incorrect

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 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.

- [ ] The dev and test sets must contain some images from the internet.
- [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: **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)	1%
Training-Dev	20,000 images randomly picked from (900,000 internet images + 60,000 car's front-facing camera images)	5.1%
Dev	20,000 images from your car's front-facing camera	5.6%
Test	20,000 images from the car's front-facing camera	6.8%

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 large data-mismatch problem.
- ○ The size of the train-dev set is too high.
- ○ You have a high bias.
- ◉ You have a high variance problem.

Expand

Correct
Correct. Since the difference between the training-dev error and the training error is 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)	2%
Training-Dev	20,000 images randomly picked from (900,000 internet images + 60,000 car's front-facing camera images)	2.3%
Dev	20,000 images from your car's front-facing camera	1.3%
Test	20,000 images from the car's front-facing camera	1.1%

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 you conclude that the Bayes error for the dev/test distribution is probably higher than for the train distribution. True/False?

- ○ True
- ◉ False

Expand

Correct

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: **0 / 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?

- (●) True
- ( ) False

Expand

Incorrect

Incorrect. 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 poin

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?

- ○ 2.2% would be a reasonable estimate of how much this windshield wiper could worsen performance in the worst case.
- ○ 2.2% would be a reasonable estimate of how much this windshield wiper will improve performance.
- ◉ 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.

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:

1 / 1 point

Which of the following do you agree with?

- ○ With this technique, we duplicate the size of the training set by synthesizing a new foggy image for each image in the training set.
- ◉ If used, the synthetic data should be added to the training set.
- ○ If used, the synthetic data should be added to the training/dev/test sets in equal proportions.
- ○ 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

Correct

Yes. The synthetic data can help to train the model to get better performance at the dev set, but shouldn't be added to the dev or test sets because they don't represent our target in a completely accurate way.

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. Which of the following is a necessary step to take? **1 / 1 point**

- (●) Correct the labels of the test set.
- ( ) Correct the labels of the train set.
- ( ) Create a train-dev set to estimate how many incorrectly labeled examples are in the train set.
- ( ) Use a correctly labeled version and an incorrectly labeled version to make the model more robust.

Expand

Correct
Correct. Recall that the dev set and the test set must come from the same distribution.

12. One of your colleagues at the startup is starting a project to classify road signs as stop, dangerous curve, construction ahead, dead-end, and speed limit signs. Given how specific the signs are, he has only a small dataset and hasn't been able to create a good model. You offer your help providing the trained weights (parameters) of your model to transfer knowledge. **1 / 1 point**

But your colleague points out that his problem has more specific items than the ones you used to train your model. This makes the transfer of knowledge impossible. True/False?

- ( ) True
- (●) False

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 bias problem.
- ◉ Large training set
- ○ Multi-task learning problem.
- ○ Problem with a high Bayes error.

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.