Congratulations! You passed!

Grade received 80% To pass 80% or higher

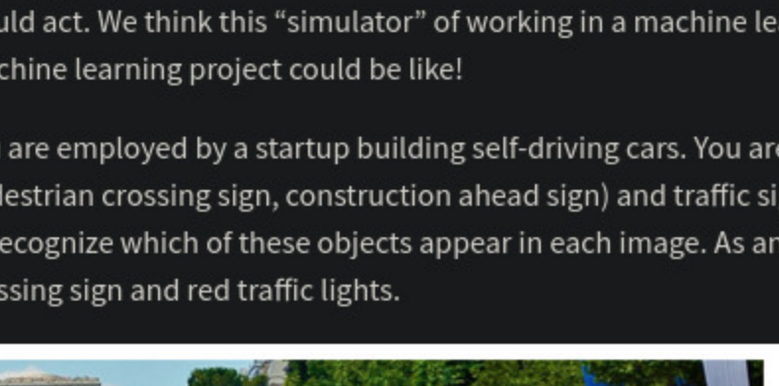
Go to next item

Autonomous Driving (Case Study)

Latest Submission Grade 80%

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 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.

You are getting started with 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 collecting more data using the front-facing camera of your car, to better understand how much data per unit time you can collect.
- ○ Invest a few days in thinking on potential difficulties, and then some more days brainstorming about possible solutions, before training any model.
- ◉ Train a basic model and do error analysis.
- ○ Spend some time searching the internet for the data most similar to the conditions you expect on production.

Expand

Correct
Applied ML is highly iterative. Having a basic model to do an error analysis can point you in the most promising directions with a lot of certainties.

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? **0 / 1 point**

- ○ ReLU
- ◉ Softmax
- ○ Sigmoid
- ○ Linear

Expand

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

- ○ 10,000 randomly chosen images
- ◉ 500 images on which the algorithm made a mistake
- ○ 500 randomly chosen images
- ○ 10,000 images on which the algorithm made a mistake

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: **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, when an image is not fully labeled (for example: $\begin{pmatrix} 0 \\ ? \\ ? \\ 1 \\ 0 \end{pmatrix}$) we can use it if we ignore those entries when calculating the loss function. True/False?

- ◉ False
- ○ True

Expand

Incorrect
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. The best way to split the data is using the 900,000 internet images to train, and divide the 100,000 images from your car's front-facing camera between dev and test sets. True/False? **1 / 1 point**

- ◉ False
- ○ True

Expand

Correct
Correct. 100,000 images are too many to use in dev and test. A better distribution would be to use 80,000 of those images to train, and split the rest between dev and test.

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

Expand

Correct
Correct. The avoidable bias is significantly high since the training error is a lot higher than the human-level error.

7. 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)	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 higher than for the train distribution. True/False?

- ◉ False
- ○ True

Expand

Incorrect
Since the training-dev error is higher than the dev and test errors probably the dev/test distribution is "easier" than the training distribution.

8. You decide to focus on the dev set and check by hand what are the errors 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	8.0%
Errors due to rain drops stuck on your car's front-facing camera	2.2%
Errors due to other causes	1.0%

In this table, 4.1%, 8.0%, etc. are a fraction of the total dev set (not just examples of your algorithm mislabeled). For example, about 8.0/15.3 = 52% of your errors are due to foggy pictures.

The results from this analysis implies that the team's highest priority should be to bring more foggy pictures into the training set so as to address the 8.0% of errors in that category. True/False?

Additional note: there are subtle concepts to consider with this question, and you may find arguments for why some answers are also correct or incorrect. We recommend that you spend time reading the feedback for this quiz, to understand what issues that you will want to consider when you are building your own machine learning project.

- ○ True because it is greater than the other error categories added together $8.0 > 4.1 + 2.2 + 1.0$.
- ○ First start with the sources of error that are least costly to fix.
- ○ True because it is the largest category of errors. We should always prioritize the largest category of errors as this will make the best use of the team's time.
- ◉ False because it depends on how easy it is to add foggy data. If foggy data is very hard and costly to collect, it might not be worth the team's effort.

Expand

Correct
Correct. This is the correct answer. You should consider the tradeoff between the data accessibility and potential improvement of your model trained on this additional data.

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%

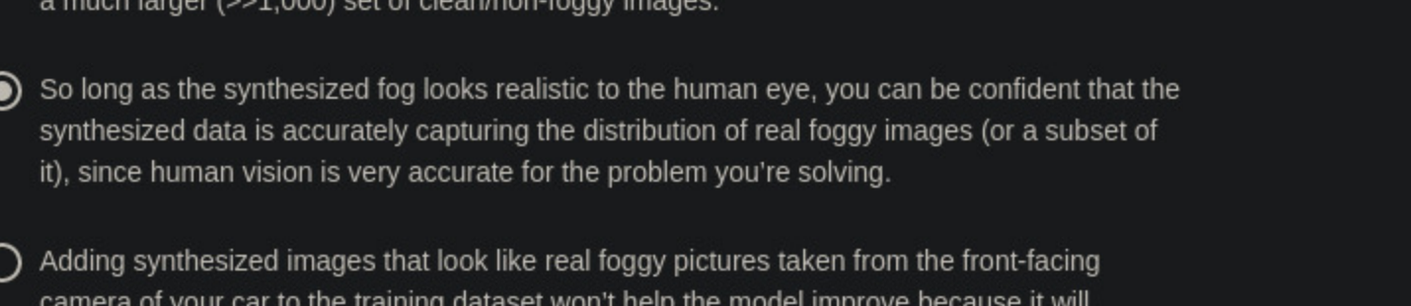
Which of the following statements do you agree with?

- ○ 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.
- ◉ 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 statements do you agree with?

- ○ There is little risk of overfitting to the 1,000 pictures of fog so long as you are combining it with a much larger (>>1,000) set of clean/non-foggy images.
- ◉ So long as the synthesized fog looks realistic to the human eye, you can be confident that the synthesized data is accurately capturing the distribution of real foggy images (or a subset of it), since human vision is very accurate for the problem you're solving.
- ○ Adding synthesized images that look like real foggy pictures taken from the front-facing camera of your car to the training dataset won't help the model improve because it will introduce avoidable bias.

Expand

Correct
Yes. If the synthesized images look realistic, then the model will just see them as if you had added useful data to identify road signs and traffic signals in foggy weather. I will very likely help.

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

Expand

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

12. Your client asks you to add the capability to detect dogs that may be crossing the road to the system. He can provide a relatively small set containing dogs. Which of the following do you agree most with? **1 / 1 point**

- ○ You will have to re-train the whole model now including the dogs' data.
- ○ You should train a single new model for the dogs' task, and leave the previous model as it is.
- ◉ You can use weights pre-trained on the original data, and fine-tune with the data now including the dogs.
- ○ Using pre-trained weights can severely hinder the ability of the model to detect dogs since they have too many learned features.

Expand

Correct
Correct. Since your model has learned useful low-level features to tackle the new task we can conserve those by using the pre-trained weights.

13. Another colleague wants to use microphones placed outside the car to better hear if there are other vehicles around you. For example, if there is a police vehicle behind you, you would be able to hear their siren. However, they don't have much to train this audio system. How can you help? **1 / 1 point**

- ○ Transfer learning from your vision dataset could help your colleague get going faster. Multi-task learning seems significantly less promising.
- ◉ Neither transfer learning nor multi-task learning seems promising.
- ○ Either transfer learning or multi-task learning could help our colleague get going faster.
- ○ Multi-task learning from your vision dataset could help your colleague get going faster. Transfer learning seems significantly less promising.

Expand

Correct
Yes. The problem he is trying to solve is quite different from yours. The different dataset structures make it probably impossible to use transfer learning or multi-task learning.

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**

- ◉ False
- ○ True

Expand

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

15. Approach A (in the question above) tends to be more promising than approach B if you have a ________ (fill in the blank). **1 / 1 point**

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