Congratulations! You passed!

Grade received 80% **Latest Submission Grade** 80% **To pass** 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 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.

$$y^{(i)} = \begin{array}{cl} \left[\begin{matrix}0\\1\\0\end{matrix}\right. & \begin{matrix}\text{“stop sign”}\\ \text{“pedestrian crossing sign”}\\ \text{“construction ahead sign”}\end{matrix}\end{array}$$

$$\begin{bmatrix} 1 \\ 0 \end{bmatrix} \begin{array}{l} \text{"red traffic light"} \\ \text{"green traffic light"} \end{array}$$

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, 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 some time searching the internet for the data most similar to the conditions you expect on production.
- 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.
- Train a basic model and do error analysis.
- Invest a few days in thinking on potential difficulties, and then some more days brainstorming about possible solutions, before training any model.

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, 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
- [x] 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. You are working out error analysis and counting up what errors the algorithm makes. Which of the following do you think you should manually go through and carefully examine, one image at a time?

1 / 1 point

- (selected) 500 images of the dev set, on which the algorithm made a mistake.
- 500 images of the train set, on which the algorithm made a mistake.
- 500 images of the training-dev set, on which the algorithm made a mistake.
- 500 images of the test set, on which the algorithm made a mistake.

Expand

Correct

Correct. We focus on images that the algorithm got wrong from the dev set. That is the one we use to make choices between different iterations of the system.

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.

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?

- ◉ 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 0.
- ○ Calculate the loss as $\sum \mathcal{L}(\hat{y}_j^{(i)}, y_j^{(i)})$ where the sum goes over all the know components of $y^{(i)}$.
- ○ Make the missing entries equal to 1.

Expand

Incorrect

It is possible to use partially labeled images in the training set; we just need to modify how we calculate the loss function.

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

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:

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, a friend thinks that the training data distribution is much harder than the dev/test distribution. What do you think?

- [x] Your friend is probably right. (i.e., Bayes error for the dev/test distribution is probably lower than for the train distribution.)
- [ ] There's insufficient information to tell if your friend is right or wrong.
- [ ] Your friend is wrong. (i.e., Bayes error for the dev/test distribution is probably higher than for the train distribution.)

Expand

Correct

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

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?

- (selected) 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?

- [x] 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 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 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

We can't use this data since they have a different distribution from the ones we used (internet and front-facing camera). True/False?

- False
- True

Expand

Correct

Correct. The new synthesized images are added to the training set and as long as they look realistic to the human eye this will be useful data to train the model.

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?

0 / 1 point

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

Expand

Incorrect

Although this is a possible strategy when the errors are systematic, we usually don't do that since we expect the model to be robust enough to overcome the differences between the training and dev distributions.

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 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.
- ○ You should train a single new model for the dogs' task, and leave the previous model as it is.

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. 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. He has approximately 30,000 examples of each image and 30,000 images without a sign. This case could benefit from using multi-task learning. True/False?

0 / 1 point

- ○ True
- ◉ False

Expand

Incorrect

There are a lot of high-level features that all the required signs share. This is a great scenario to make use of multi-task learning.

14. When building a system to detect cattle crossing a road from images taken with the front-facing camera of a truck, the designers had a large dataset of images. Which of the following might be a reason to use an end-to-end approach?

1 / 1 point

- ( ) It requires less computational resources.
- (•) There is a large dataset available.
- ( ) This approach will make use of useful hand-designed components.
- ( ) That is the default approach on computer vision tasks.

Expand

Correct

Correct. To get good results when using an end-to-end approach, it is necessary to have a big dataset.

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).

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

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.