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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.



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

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, 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).

- ☒ Train a basic model and proceed with error analysis.
- ☐ Leave aside the pedestrian detection, to move faster and then later solve the pedestrian problem alone.
- ☐ Start by solving pedestrian detection, since you already have the experience to do this.
- ☐ Spend a few days collecting more data to determine how hard it will be to include more pedestrians in your dataset.

 Expand

 Correct


Correct. As discussed in the lecture, it is better to create your first system quickly and then iterate.

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

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

- ☒ 500 images on which the algorithm made a mistake
- ☐ 10,000 images on which the algorithm made a mistake
- ☐ 10,000 randomly chosen images
- ☐ 500 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.

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?

- ☐ True
- ☒ False

[Expand](#)

✓ Correct

As seen in the lecture on multi-task learning, you can compute the cost such that it is not influenced by the fact that some entries haven't been labeled.

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

- ☐ True
- ☒ False

[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:

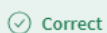
1 / 1 point

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:

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 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.

- ☒ 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.
- ☐ 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.

 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 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 find out that there is an anti-reflective film guarantee to eliminate the sun reflection, but it is quite costly. Which of the following gives the best description of what the investment in the film can do to the model?

- ☐ The overall test set error will be reduced by at most 7.2%.
- ☐ The film will reduce at least 7.2% of the dev set error.
- ☒ The film will reduce the dev set error with 7.2% at the most.

 Expand

 Correct

Yes. Remember that this 7.2% gives us an estimate for the ceiling of how much the error can be reduced when the cause is fixed.

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?

- ☒ 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.
- ☐ 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.

[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?

0 / 1 point

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

 Expand

 Correct

Correct. The model can benefit from the pre-trained model since there are many features learned by your model that can be used in the new problem.

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?

1 / 1 point

- ☒ True
- ☐ False

 Expand

 Correct

Correct. 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. To recognize a stop sign you use the following approach: First, you use a neural network to predict bounding box coordinates around all traffic signs (if any) within an input image. You then pass the results to a different neural network to determine if the predicted traffic signs (if any) are 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. Since there are 2 different neural networks being used here that do not share weights (i.e. structure), this problem has 2 single task learning neural networks and not a multi-task learning setup.

15. To recognize a stop sign you use the following approach:

0 / 1 point

First, we localize any traffic sign in an image. After that, we determine if the sign is a stop sign or not.

This is a better approach than an end-to-end model for which of the following cases? Choose the best answer.

☐ There are available models which we can use to transfer knowledge.

☐ There is not enough data to train a big neural network.

☒ The problem has a high Bayes error.

☐ There is a large amount of data.

[↗ Expand](#)

✗ Incorrect

No, such aspects don't play a major role in deciding whether to use an end-to-end approach or not.