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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 an idea of what leading a machine learning project could be like!

0 / 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.

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

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).

- ○ 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.
- ○ 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.

Expand

Incorrect
Doing a detailed error analysis of a basic model can help us determine confidently if the system will truly benefit from the extra data.

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

- ◉ False
- ○ True

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

- [ ] 500 images of the training-dev set, on which the algorithm made a mistake.
- [ ] 500 images of the train set, on which the algorithm made a mistake.
- [x] 500 images of the 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:

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, 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?

- [x] True
- [ ] False

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. 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

- [x] 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 of the data:

1 / 1 point

		Error of the

Dataset:	Contains:	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%. Which of the following are True? (Check all that apply).

- [x] You have a large data-mismatch problem because your model does a lot better on the training-dev set than on the dev set

✓ Correct

- [ ] You have a large variance problem because your training error is quite higher than the human-level error.
- [x] You have a large avoidable-bias problem because your training error is quite a bit higher than the human-level error.

✓ Correct

- [ ] Your algorithm overfits the dev set because the error of the dev and test sets are very close.
- [ ] You have a large variance problem because your model is not generalizing well to data from the same training distribution but that it has never seen before.

Expand

Correct
Great, you got all the right answers.

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	2.0%
Errors due to partially occluded elements.	8.2%
Errors due to other causes	1.0%

In this table, 4.1%, 8.2%, etc. are a fraction of the total dev set (not just examples of your algorithm mislabeled). For example, about 8.2/15.3 = 54% of your errors are due to partially occluded elements in the image.

Which of the following is the correct analysis to determine what to prioritize next?

○ You should prioritize getting more foggy pictures since that will be easier to solve.

◉ Since 8.2 > 4.1 + 2.0 + 1.0, the priority should be to get more images with partially occluded elements.

○ Since there is a high number of incorrectly labeled data in the dev set, you should prioritize fixing the labels on the whole training set.

○ You should weigh how costly it would be to get more images with partially occluded elements, to decide if the team should work on it or not.

Expand

Incorrect
The choice should be made taking into consideration other aspects, not just this.

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 in the image.

From this table, we can conclude that if we fix the incorrectly labeled data we will reduce the overall dev set error to 11.2%. True/False?

◉ False

○ True

Expand

Correct
Correct. The 4.1 only gives you an estimate of the ceiling of how much the error can be improved by fixing the labels.

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?

○ It is irrelevant how the resulting foggy images are perceived by the human eye, the most important thing is that they are correctly synthesized.

○ 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

With this technique, we duplicate the size of the training set by synthesizing a new foggy image for each image in the training set.

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 on the dev set. Which of these statements do you agree with? (Check all that apply).

1 / 1 point

- [ ] You should correct incorrectly labeled data in the training set as well so as to avoid your training set now being even more different from your dev set.
- [ ] You should not correct the incorrectly labeled data in the test set, so that the dev and test sets continue to come from the same distribution.
- [x] You should also correct the incorrectly labeled data in the test set, so that the dev and test sets continue to come from the same distribution.

Correct
Yes because you want to make sure that your dev and test data come from the same distribution for your algorithm to make your team's iterative development process efficient.

- [x] You do not necessarily need to fix the incorrectly labeled data in the training set, because it's okay for the training set distribution to differ from the dev and test sets. Note that it is important that the dev set and test set have the same distribution.

Correct
True, deep learning algorithms are quite robust to having slightly different train and dev distributions.

Expand

Correct
Great, you got all the right answers.

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?

- ○ Recommend that she try multi-task learning instead of transfer learning using all the data.
- ○ 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.
- ○ 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.

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. 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

- ◉ Neither transfer learning nor multi-task learning seems promising.
- ○ Multi-task learning from your vision dataset could help your colleague get going faster. Transfer learning seems significantly less promising.
- ○ Either transfer learning or multi-task learning could help our colleague get going faster.
- ○ Transfer learning from your vision dataset could help your colleague get going faster. Multi-task 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 red and green lights, you have been using this approach: **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).

A teammate proposes a different, two-step approach:

- **(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.

Between these two, Approach B is more of an end-to-end approach because it has distinct steps for the input end and the output end. True/False?

- ○ True
- ◉ False

Expand

Correct
Yes. (A) is an end-to-end approach as it maps directly the input (x) to the output (y).

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.
- ◉ The problem has a high Bayes error.
- ○ There is not enough data to train a big neural network.
- ○ 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.