

CS230: Lecture 5

Case Study

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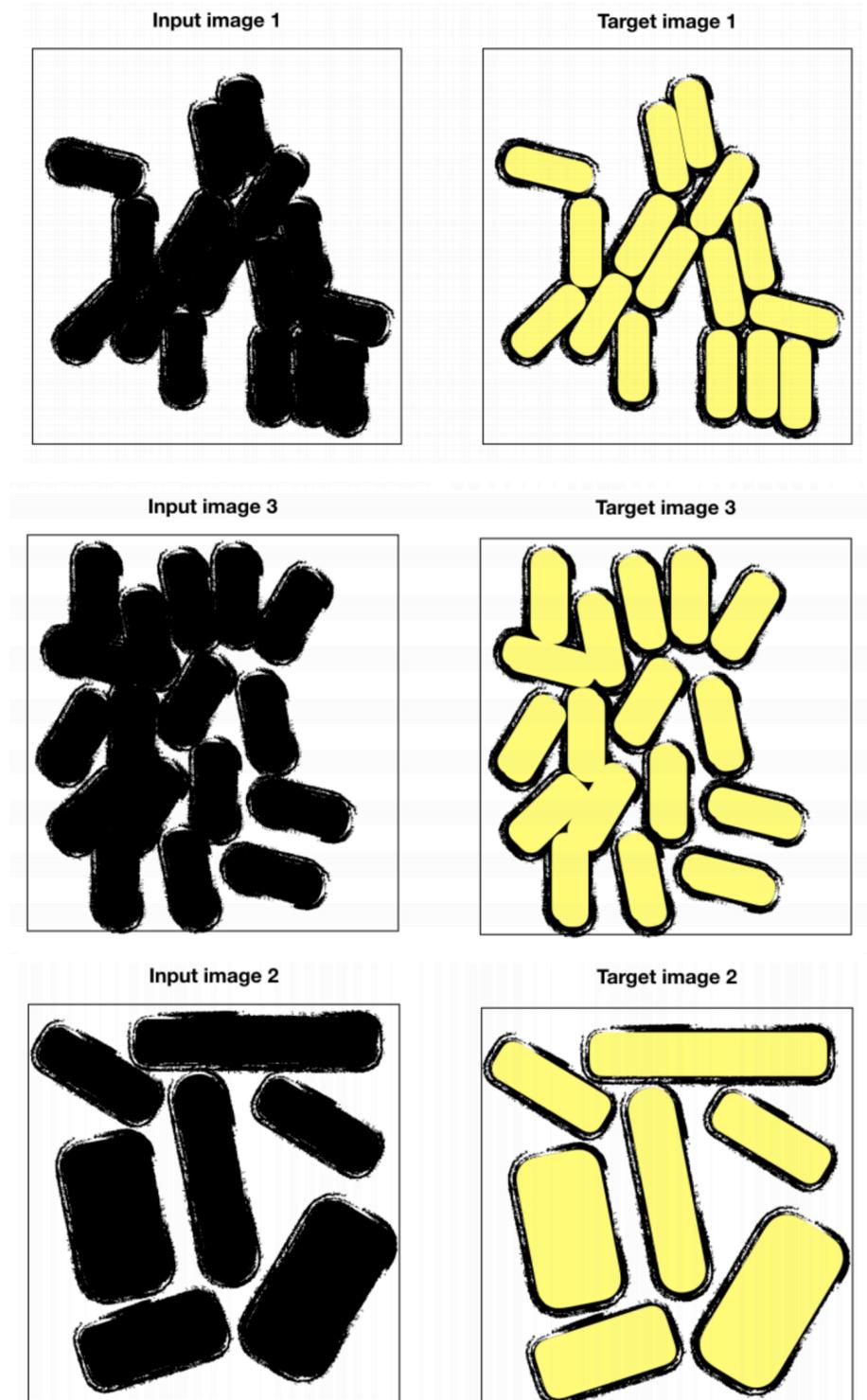
Problem statement: cell segmentation

Goal: Determine which parts of a microscope image corresponds to which individual cells.

Data: Doctors have collected 100,000 images from microscopes and gave them to you. Images have been taken from three types of microscopes:

Type A	50,000 images
Type B	25,000 images
Type C	25,000 images

Question: The doctors who hired you would like to use your algorithm on images from microscope C. How you would split this dataset into train, dev and test sets?



Data

Question: The doctors who hired you would like to use your algorithm on images from microscope C. How you would split this dataset into train, dev and test sets?

Answer:

- i) Split has to be roughly 90,5,5. Not 60,20,20.
- ii) Distribution of dev and test set have to be the same (contain images from C).
- iii) There should be C images in the training as well, more than in the test/dev set.

Question: Can you augment this dataset? If yes, give only 3 distinct methods you would use. If no, explain why (give only 2 reasons).

Answer: Many augmentation methods would work in this case:

- cropping
- adding random noise
- changing contrast, blurring.
- flip
- rotate

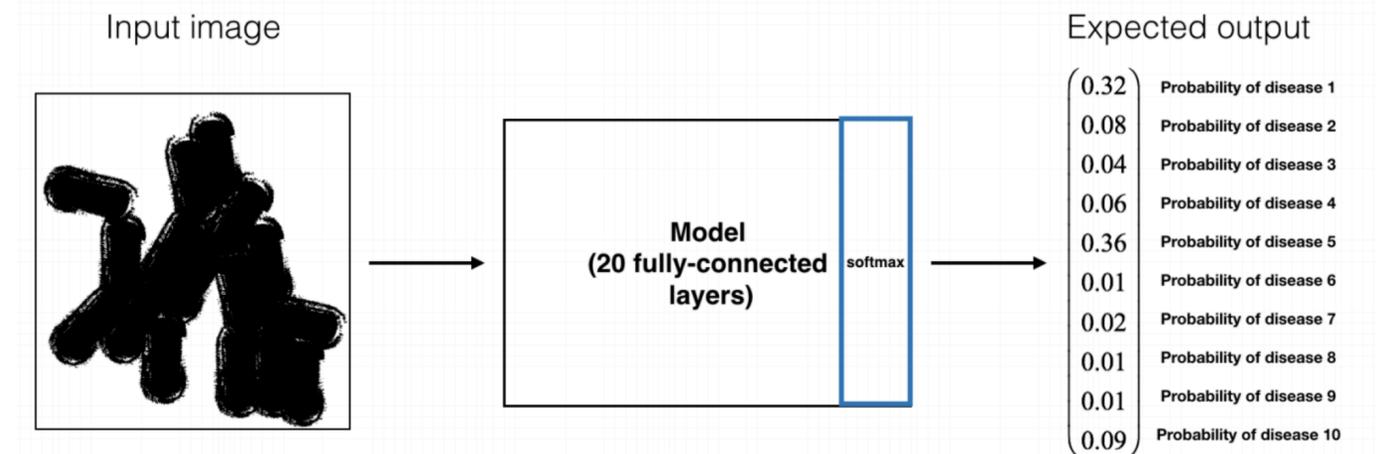
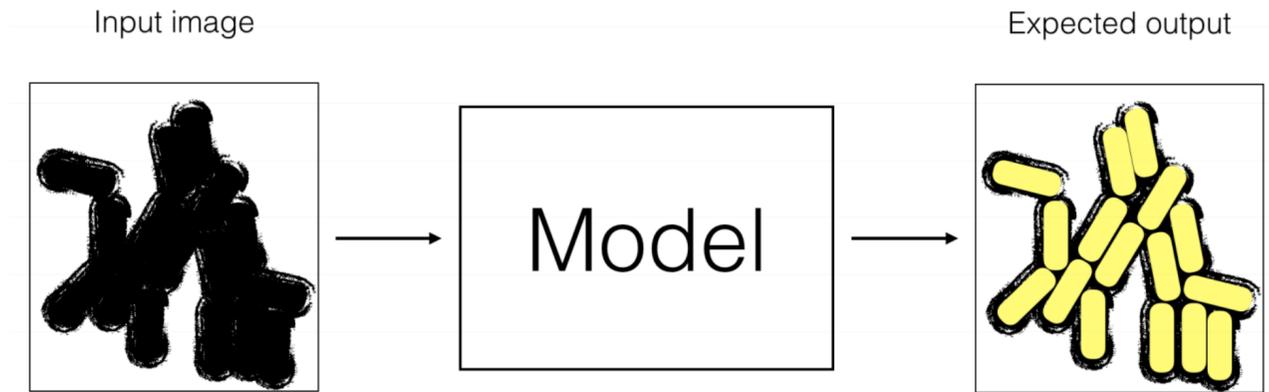
Transfer Learning

First try: You have coded your neural network (model M1) and have trained it for 1000 epochs. It doesn't perform well.

Transfer Learning: One of your friends suggested to use transfer learning using **another labeled dataset** made of 1,000,000 microscope images for skin disease classification (very similar images).

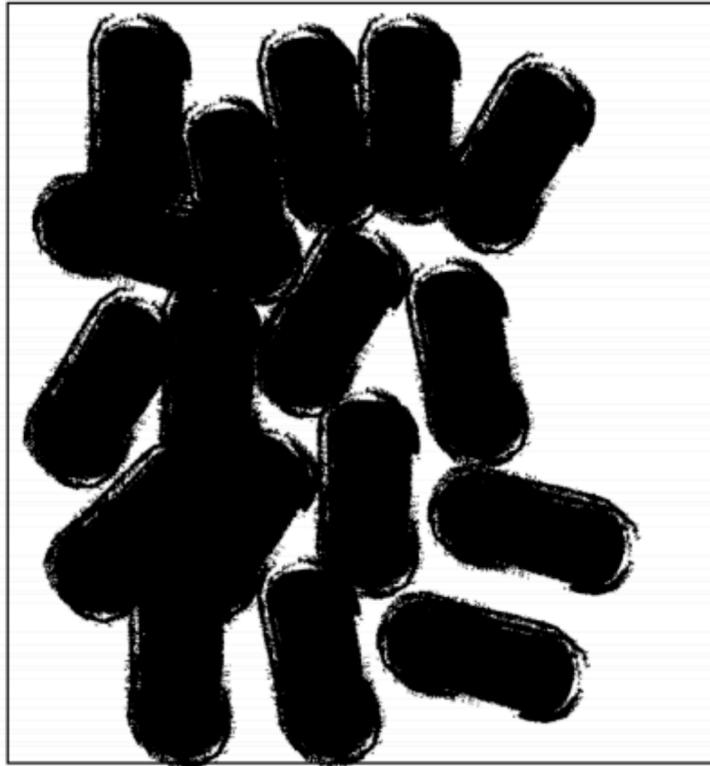
A model (M2) has been trained on this dataset on a 10-class classification. Here is an example of input/output of the model M2.

Question: You perform transfer learning from M2 to M1, what are the new hyperparameters that you'll have to tune?

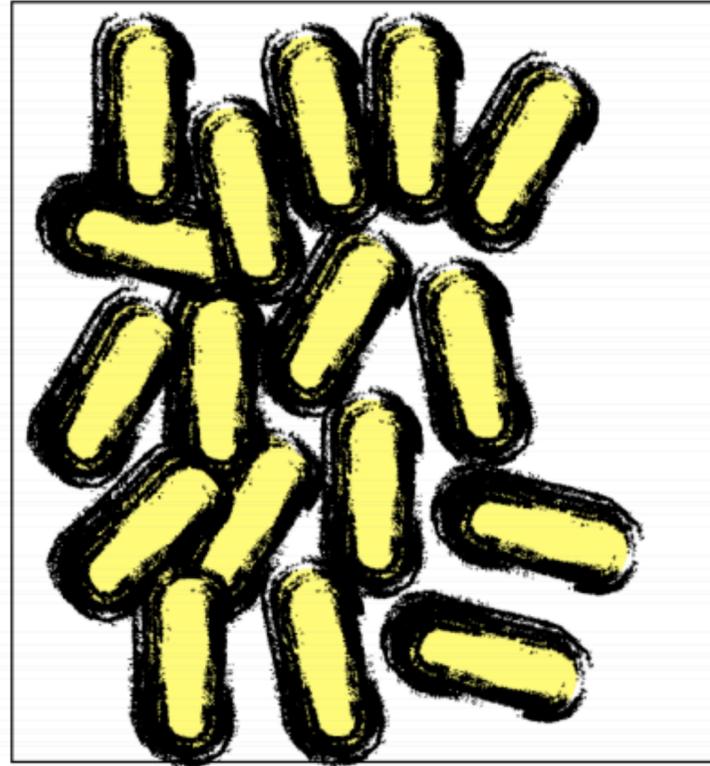


Network modification

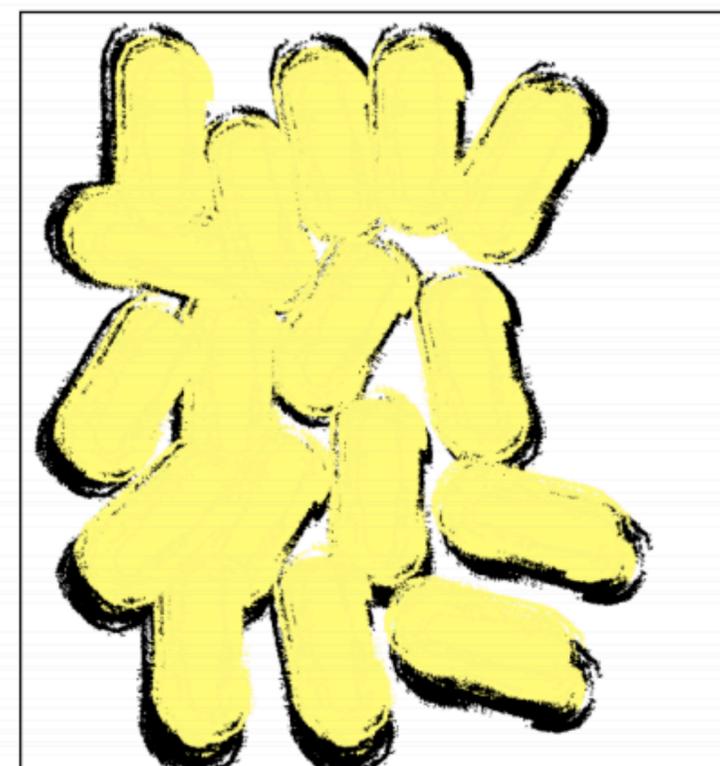
Input image



Output that doctors want



What your algorithm outputs



Question: How can you correct your model and/or dataset to satisfy the doctors' request?

Answer: Modify the dataset in order to label the boundaries between cells. On top of that, change the loss function to give more weight to boundaries or penalize false positives.

$$L_{binary} = - \sum_{i=1}^{n_y} (3y_i \log(\hat{y}_i) + (1 - y_i) \log(1 - \hat{y}_i))$$

$$L_{multi-class} = - \sum_{i=1}^{n_y} w_{y_i} y_i \cdot \log(\hat{y}_i)$$

$$w_{y_i} = \begin{cases} 1 & \text{if } y_i = (1,0,0) \\ 5 & \text{if } y_i = (0,1,0) \\ 3 & \text{if } y_i = (0,0,1) \end{cases}$$

Network modification

New goal: Doctors give you a new dataset containing images similar to the original data set. The difference is that each image is labeled as 0 (there are no cancer cells on the image) or 1 (there are cancer cells on the image). You easily build a state-of-the-art model to classify these images with 99% accuracy. The doctors ask you to explain your network's predictions.

Question: Given an image classified as 1 (cancer present), how can you figure out based on which cell(s) the model predicted 1?

Answer: Gradient of output w.r.t. input X

Question: Your model detects cancer on cells (test set) images with 99% accuracy, while a doctor would on average perform 97% accuracy on the same task. Is this possible? Explain.

Answer: If the dataset was entirely labeled by this one doctor with 97% accuracy, it is unlikely that the model can perform at 99% accuracy. However if annotated by multiple doctors, the network will learn from these several doctors and be able to outperform the one doctor with 97% accuracy. In this case, a panel composed of the doctors who labeled the data would likely perform at 99% accuracy or higher.

Duties for next week

For next Tuesday 02/11, 8am: C4M1 and C4M2

This Friday (02/07): TA Section