CS230: Lecture 5

Case Study

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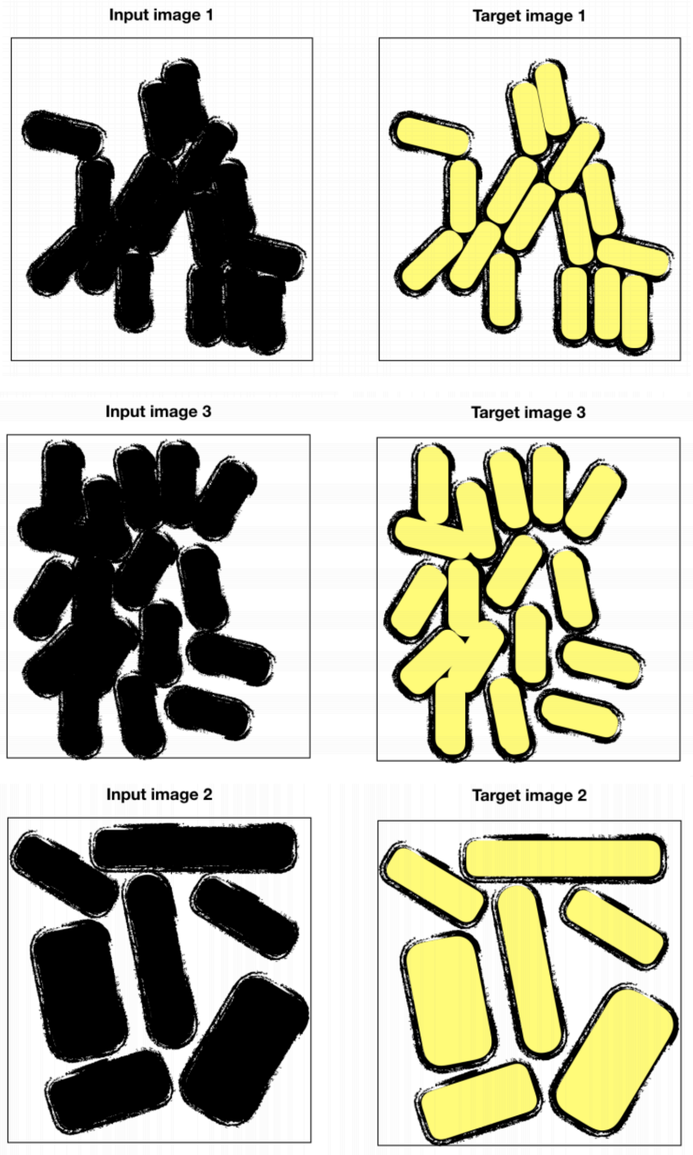
Problem statement: cell segmentation

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

Architecture and Loss

Question:

- What is the mathematical relation between nx and ny?
- What's the last activation of your network?
- What loss function should you use?

Answer:

i) nx = 3 × ny

ii) Sigmoid activation

iii) Summation over all pixel value with cross entropy loss.

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

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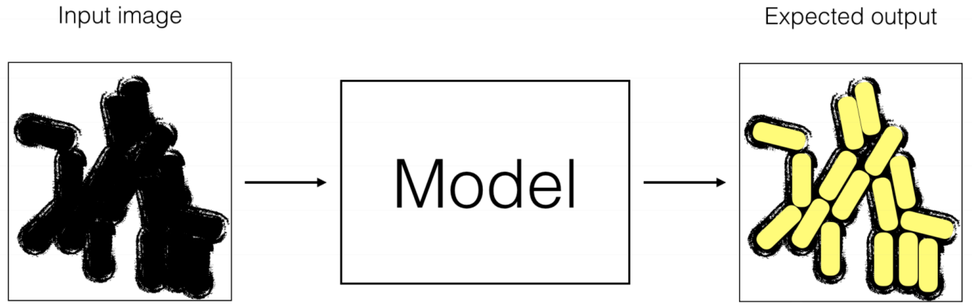
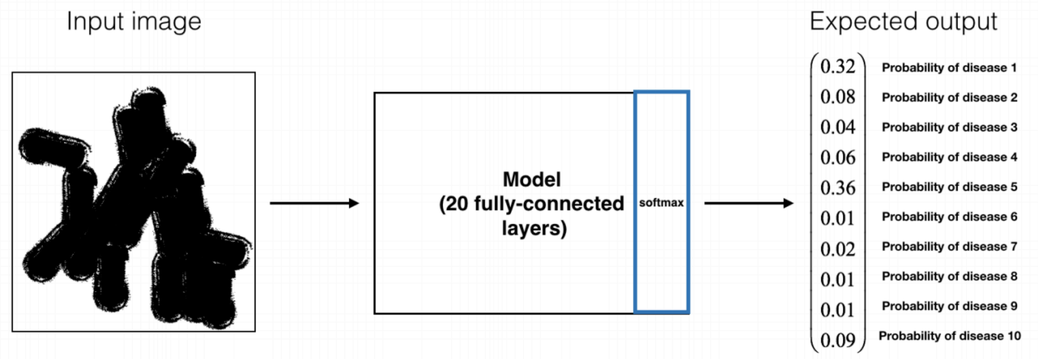
Transfer Learning

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



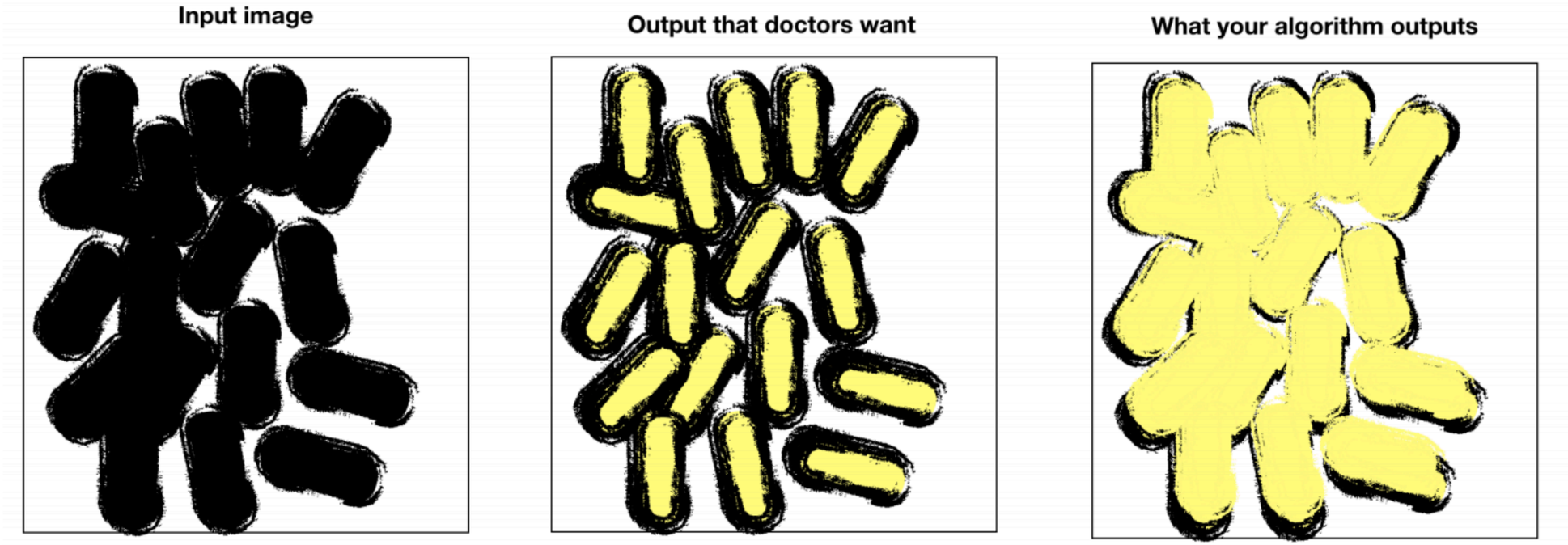
Transfer Learning: One of your friends suggested to use transfer learning using **another labeled dataset** made of 1,000,000 microscope images for skin disease classification (very similar images).

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



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.

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Network modification

New goal: They give you a dataset containing images similar to the previous ones. 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 are astonished and surprised, they 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?

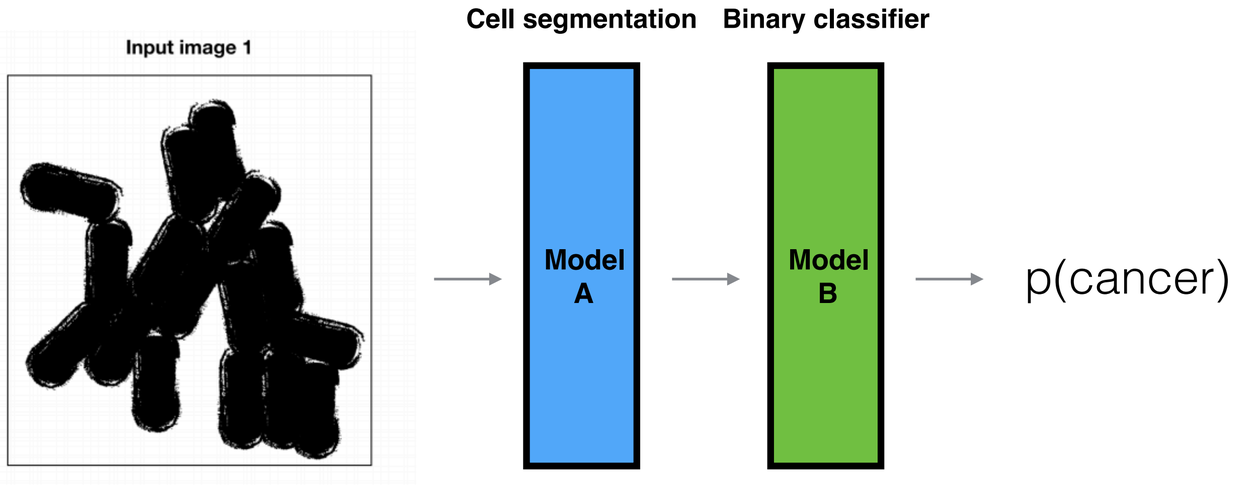
Answer: Gradient of output w.r.t. input X

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.

Network modification

New new goal: To solve your binary classification (presence/absence of cancer cell(s)), you decided to implement the following pipeline.



Question:

(i) What are the advantages/disadvantages of this model compared to the previous end-to-end binary classifier?

(ii) If your model doesn't perform well, how can you find what the problem is?

Answer: (i) +: requires less data in general by leveraging human crafted knowledge. Still works if labelled data is not present in both ends. -: might limit the model's potential performance if the hand-engineered components aren't optimal. (ii)

[Machine Learning Yearning, Andrew Ng, deeplearning.ai]

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Duties for next week

For next Wednesday 10/31, 11am:

C4M1

- **Quiz: The basics of ConvNets**
- **Programming Assignment: Convolutional Neural Network - Step by Step**
- **Programming Assignment: Convolutional Neural Network - Application**

C4M2

- **Quiz: Convolutional models**
- **Programming Assignment: Keras Tutorial (optional, but highly recommended)**
- **Programming Assignment: Residual Networks**

Midterm, on 11/02: everything up to C4M2 (included), TA sections and next Wednesday's in-class lecture can be expected.

This Friday (10/26): TA section