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Test your PA3 with images of numbers

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Hi, in this thread I want to show you a way to test the model created in PA3 with images of numbers. I think that you would enjoy more this programming assignment if you can see that it really works.

M

First of all we have to modify the function a3 to save the model. It's very easy, just add this line at the end of the function.

```
function a3(wd_coefficient, n_hid, n_iters, learning_rate, mo
mentum_multiplier, do_early_stopping, mini_batch_size)
.
.
.
save -mat7-binary model.mat model;     %save the model
end
```

Ok, now create a file called a3Test.m and paste this code.

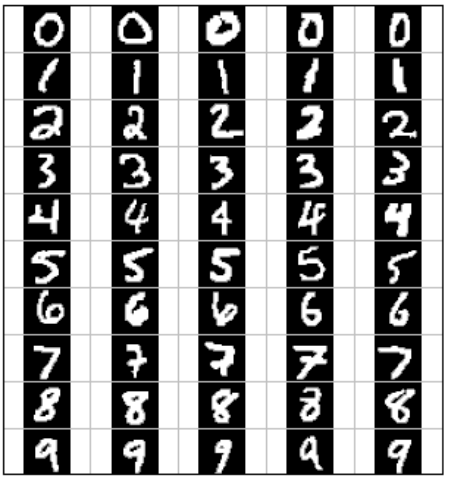
```
function a3Test(imageName)
%a3Test gets the name of the image as an input and displays t
he
%probabilities of each number
%imageName  name of the image to load
    close all;  %close all figures

%Load the model
    load model;    %load the model of the network
%Load the image and transform it
    number=imread(imageName);    %read the image file
    imshow(number);         %show the image
    movegui('northwest');
    number=im2double(number);   %transform the format from 8b
it to double
    number = number';       %this is just to adapt to USPS da
tabase
    data=number(:);         %finally transform the matrix int
o a vector
%Compute the probabilities
    probabilities = computeProbabilities(model, data);
%Show the probabilities in a graph
  figure;
  numbers = [ 0 1 2 3 4 5 6 7 8 9];
  bar(numbers,probabilities);
  movegui('northeast');
end

function ret = logistic(input)
  ret = 1 ./ (1 + exp(-input));
end

function ret = log_sum_exp_over_rows(a)
  % This computes log(sum(exp(a), 1)) in a numerically stable
 way
  maxs_small = max(a, [], 1);
  maxs_big = repmat(maxs_small, [size(a, 1), 1]);
```

```
  ret = log(sum(exp(a - maxs_big), 1)) + maxs_small;
end

function ret = computeProbabilities(model, data, wd_coefficient)
  % model.input_to_hid is a matrix of size (n_hid,256)
  % model.hid_to_class is a matrix of size (10,256)
  % data.inputs is a matrix of size (256,<number of data cases>)
  % data.outputs is a matrix of size (10,<number of data cases>)

  % first, do the forward pass, i.e. calculate a variety of relevant values
  hid_in = model.input_to_hid * data; % input to the hidden units, i.e. before the logistic. size: (n_hid,<number of data cases>)
  hid_out = logistic(hid_in); % output of the hidden units, i.e. after the logistic. size: (n_hid,<number of data cases>)
  class_in = model.hid_to_class * hid_out; % input to the components of the softmax. size: (10, <number of data cases>)
  class_normalizer = log_sum_exp_over_rows(class_in); % log(sum(exp)) is what we subtract to get normalized log class probabilities. size: (1,<number of data cases>)
  log_class_prob = class_in - repmat(class_normalizer, [size(class_in, 1), 1]); % log of probability of each class. size: (10, <number of data cases>)
  class_out = exp(log_class_prob); % probability of each class. Each column (i.e. each case) sums to 1. size: (10, <number of data cases>)
  ret = class_out;

end



%Theta is a column vector that holds the weights
%Model contains two matrix (,) with the weights
function ret = theta_to_model(theta)
  n_hid = size(theta, 1) / (256+10);
  ret.input_to_hid = transpose(reshape(theta(1: 256*n_hid), 256, n_hid));
  ret.hid_to_class = reshape(theta(256 * n_hid + 1 : size(theta,1)), n_hid, 10).';
end

function ret = model_to_theta(model)
  input_to_hid_transpose = transpose(model.input_to_hid);
  hid_to_class_transpose = transpose(model.hid_to_class);
  ret = [input_to_hid_transpose(:); hid_to_class_transpose(:)];
end
```

Great, now we need 16x16 greyscale images to test the code. You can use a program like Photoshop as I do in the next video o you can get images from the dataset writing something like this:

```
imwrite((reshape(data.training.inputs(:,8)',16,16)'),'number7.jpg')
```

The images will look like these ones:



You can watch how it works in this video: http://youtu.be/OPfL4SJkjno

Guillermo Barbadillo
on Sun 4 Nov 2012 4:18 PM CET

Comments

0

Very nice. I just linked to it.

John Rood
on Sun 4 Nov 2012 9:10 PM CET

0

It is great to see how vulnerable this feed forward neural network to variances. I draw a vertical line to the right, instead of the middle, of the screen and it is recognized as 3 with .88 probability :)

by the way add the following code to see the probabilities on the plot:

```
for i = 1:length(numbers)
    text(i-1,probabilities(i)+0.04,num2str(probabi
lities(i),2),'Color','r','HorizontalAlignment','ce
nter')
end
```

and thanks!

Özgür Aydoğan
on Thu 15 Nov 2012 5:10 PM CET

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Very nice Guillermo, thanks! It always helps a lot to get a more concrete feel for what all these numbers, gradients, matrices, etc, are actually doing. Visualization is an important part of Neural Network research.

Tijmen Tieleman (Staff)
on Sun 4 Nov 2012 6:17 PM CET

Comments
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Thank you :)

[Delete] Guillermo Barbadillo
on Thu 8 Nov 2012 5:00 PM CET

-1

Tijmen, i am hoping that someone, Prof Hinton?, you?, both?, others as well?, will *speak to this issue*. In the introductory video for this course, iirc, Prof Hinton talks about what the neural network [or George Bush?] "sees" and what the human mind sees [literally?].

I would be interested to hear how (human) visualization its into the picture of research on neural networks.

Hmmm. Please allow me a technical detail. Jean Dieudonné famously mentions, in his *Traité d'Analyse,* that he has deliberately "refrained from introducing even a single diagram" into the book, because mathematics is supposed to proceed axiomatically (logically), not intuitively. [Paraphrase from memory, but i can find the exact quote if need be.]

I am wondering about, among other things, whether this comment has anything to do with the study of neural networks. Ultimately, if we are doing something like "the mind" does, doesn't that mean we need to avoid any kind of *causa sui* -like argument?

So we shouldn't have to *use visualization* to simulate vision ... ?

And, vice versa, if you will, what does it mean if we *do* rely on visualization to come to understand our subject matter? Does the subject matter help us to understand visualization ... and vision? Certainly i would say the subject *aims* to do this, if you will ... ?

John Rood
on Thu 8 Nov 2012 5:58 PM CET

0

typo: "its" should be "fits" in the 2nd paragraph

also: http://en.wikipedia.org/wiki/Causa_sui

John Rood
on Thu 8 Nov 2012 6:02 PM CET

2

Hi John, visualization is a big part of NN research. Most NN researchers couldn't care less about the analogies with human brains (Hinton is the biggest exception to that rule - he famously pursues this research to with the goal of finding out how the brain works), but that doesn't take away the fact that NN's are hard to inspect, and any images can be hugely helpful.

Tijmen Tieleman (Staff)
on Thu 8 Nov 2012 6:19 PM CET

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