

HW4: Graph Cuts and Deep Learning

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CS 6320 - 3D Computer Vision
Due: 11:59 PM on 04/02/2017

Please submit a PDF document with solutions to all the problems. Handwritten solutions are allowed for the first 4 questions.

1. Show that the following function (all the variables are Boolean) is submodular using the set definition:

$$f(x_1, x_2, x_3) = 2x_1 - x_1x_2 - 2x_2x_3 \quad (1)$$

[10 points]

2. Show that the following function (all the variables are Boolean) is not submodular using the set definition:

$$f(x_1, x_2, x_3) = 2x_1 - x_1x_2 + 2x_2x_3 \quad (2)$$

[10 points]

3. Show the maxflow/mincut graph for the following equation:

$$f(x_1, x_2, x_3, x_4) = -2x_1 + 3x_2 + 5x_3 + 7x_4 - x_1x_2 - 2x_2x_3 - 4x_1x_4 - 5x_2x_4 \quad (3)$$

Manually identify the best solution (all the variables are Boolean) and show the corresponding cut on the graph. Show that the cost of the cut matches with the cost of the function (without the introduced constant term). [20 points]

4. Consider a multi-label problem with 2 variables y_1 and y_2 each taking 3 states $\{1, 2, 3\}$. Let the unary and pairwise terms be given by $\theta_{y_1}^l = \{[l = 1] - > 0.5, [2] - > 1.5, [3] - > 1.0\}$, $\theta_{y_2}^l = \{[l = 1] - > 1.5, [2] - > 1.5, [3] - > 0.0\}$, and $\theta_{y_1y_2}^{lm} = \{[lm = 11] - > 0, [12] - > 1, [13] - > 1, [21] - > 1, [22] - > 0, [23] - > 1, [31] - > 1, [32] - > 1, [33] - > 0\}$. Show the iterations in alpha-expansion till it converges. Note that you will construct a Boolean function in every iteration. You will manually compute the solution for every maxflow/mincut step. [30 points]
5. Install any deep learning package (Caffe, tensorflow) and test the MNIST digit recognition program. You don't have to understand the details of the program, but try to change the number of layers or other parameters and observe the change in the accuracy of the digit recognition. The following websites will be useful:

https://www.tensorflow.org/get_started/mnist/beginners

<http://caffe.berkeleyvision.org/gathered/examples/mnist.html>

Show the outputs for 2 different parameter settings in the PDF [30 points].