ECS222a Graduate Algorithms
Homework 3

You are encouraged to talk to other people about these problems, but please **write up the solutions by yourself**. Always explain the answer in **your own words**; do not copy text from the book, other books, Web sites, your friends' homework, your friend's homework from last year, etc. If you use other books, Web sites, journal papers, etc. to get a solution, cite the reference and explain the solution in your own words, so that we can tell that you understand the material you are using. Always explain your solution as you would to someone who does not understand it, for instance to a beginning graduate student or an advanced undergraduate.

Please type your homework. If you know LaTeX, use that. If not, you may ype your answers in any word processing system and write in mathematical notation by hand as necessary. Include pictures if appropriate; you can draw in pictures by hand or include them in the file.

1. Do problem 15-5.

2. Do problem 26-4.

3. This problem gives an example of how max-flow min-cut algorithms are used in computer vision. We are given a grayscale image of a light-colored dog against a dark-colored background, and we want to produce a black and white image, assigning each pixel either to the dog or to the background. We want the boundary between the white and black portions of the output image to be as smooth as we reasonably can make it, so we decide to color pixels black and white so as to optimize the following objective function:

$$\left(\sum_{\text{pixel}_{ij}} |\text{grayscale}_{ij} - \text{bw}_{ij}| \right) + 32 \times \text{number of boundary edges}$$

   where bw_{ij} is 0 for black and 255 for white, and $\text{grayscale}_{ij} \in \{0 \ldots 255\}$ is the shade of grey in the original image, and a *boundary edge* is one which separates a black pixel from a white pixel. Show how to formulate this problem a max-flow min-cut.

4. Do problem 29.2-7