Intro to Image Understanding (CSC420)
Assignment 5

Submission Deadline : Nov 30 (Sunday), 11.59pm, 2014

Max points: 10, max extra credit points: 5, additional 3 for fast submitters

(1) You are given a short video clip broken down into consecutive frames. For each frame you are also provided with a set of detection boxes for the *person* class obtained via the Deformable Part-based Model (DPM). The data is structured in the following way:

- The frames are in DATA/FRAMES
- The detections are in DATA/DETECTIONS. Each frame has its own mat file which contains a variable DETS. This variable has the same structure as DS in DEMO_CAR function in Assignment4. Thus, each row of DETS is $[\text{left}, \text{top}, \text{right}, \text{bottom}, \text{id}, \text{score}]$, specifying the coordinates of the detection box, and its confidence (score).

Your task is to complete a function called CODE/TRACK_OBJECTS.M. This function loads detections of two consecutive frames, and computes similarity between each detection in frame i and each detection in frame $i + 1$. Your goal is to find an assignment between detections in frames of the videos, that are believed to correspond to the same, possibly moving, object. The assignment between detections in multiple frames is called a *track*. There are several different options of how to do that, and you should pick one (you can implement all, but only one will count in your grade):

(a) **(6 points)** Greedy method: Assign two detections with the highest similarity, remove them from the list, find the next most similar detections, etc.

(b) **(6 points + 2 extra credit)** Hungarian method: Implement the optimal bi-partite graph matching between the two sets of detections. Be careful as the number of detections across the frames may change.

(c) **(6 points + 5 extra credit)** Dynamic Programming: Find the best path across detections in all frames. Remove the path from the list. Find the next best path, etc. The best path is the path with:

$$\max_{i_1 \in F_1, i_2 \in F_2, \dots i_n \in F_n} (\text{sim}(det_{i_1}, det_{i_2}) + \text{sim}(det_{i_2}, det_{i_3}) + \cdots + \text{sim}(det_{i_{n-1}}, det_{i_n}),$$

where F_j is the set of all detections in the j-th frame, and det_{i_j} is a detection in the j-th frame.

In your solution document, include a short explanation of your method. Include also the code, i.e., the complete TRACK_OBJECTS plus any other function you may have written for this purpose.

(2) **(3 points)** Visualize your solution. Plot each frame with all detections (boxes) that have been tracked for more than 5 frames. Each different track should have a rectangle (box) of different color, however all detections corresponding to the same track should have the same color. The easiest to generate a color palette is with e.g.: COL=COLORMAP('LINES');, which gives you a set of different colors (ear row is a color). Plotting a box with a color, e.g.: RECTANGLE('POSITION',

[LEFT,TOP,WIDTH,HEIGHT], 'EDGECOLOR',[1,0,0], 'LINEWIDTH', 2). Store a visualization of each frame in a directory called TRACKS. You do not need to insert the frames into your solution document. Simply include the TRACKS directory in a zip file along with your document and upload to CDF.

Do not worry if you don't track all the players. Some of them may not be detected in all the frames. Any idea how to deal with missing detections? No need to write code, just write down your idea.

(3) **(1 point)** How would you find a circle of an unknown radius in an image? Don't write code, a written answer will do.

(4) **(extra credit for fast submitters)** The fastest 5 submitters for each (a), (b) or (c) tasks above have the chance of getting additional 3 points. Anyone that submits before Nov 23 (Sunday) 23.59pm has the chance of getting 2 points (if you're in the top fastest 5, you only get 3 points and not this extra 2). In order to compete for extra credit you need to answer the following question correctly: Among all your tracks how would you find the soccer player that was running the fastest? Be careful with your answer: a player very far away seems to move less in an image, but the player may in fact have been running like Flash. You do **not need to provide any code**, just a written answer will do.