CS585 Assignment 4 Written Part

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Exercise 1: Tracking by Detection

> *What is meant by the term "tracking by detection" in computer vision?*

We perform "tracking" by detecting the centroid of the object in each successive frame. This only works well for single-object tracking, not so much for multi-object tracking. And, of course, this method is entirely memory-less, in that the detection of every frame is independent of the detection of any other frame.

Exercise 2: Tracking by State Estimation

> (a) *Briefly describe an advantage of using an alpha-beta filter over a Kalman filter.*

Unlike in a Kalman filter, an alpha-beta filter does not require a transition model and only works with "position" and "velocity," where "position" is the time integral of "velocity," just like in physics. The underlying assumption is that an object's velocity stays roughly constant between every consecutive pair of frames. Despite its rather often inaccuracies, it is computationally efficient.

> (b) *Briefly describe an advantage of using a Kalman filter over an alpha-beta filter.*

Unlike an alpha-beta filter, a Kalman filter requires a transition model, which makes it computationally more expensive but much more accurate. More accurate, because the transition models and the observation models are updated at each time step (a.k.a frame). So, if we have a way to obtain such a transition model exists and if we can afford to run computationally more expensive algorithms, then we should opt for a Kalman filter over an alpha-beta filter.

Exercise 3: Multi-Object Tracking by Data Association

> (a) *Briefly describe an advantage of using GNNSF over MHT.*

GNNSF's loss function is computationally less expensive, compared to MHT's loss function, to minimize. However, the disadvantage is that once a measure-to-track assignment is done, it cannot be re-done; consequently, any future data point that might carry useful information for updating such an assignment is entirely useless — a common drawback of *greedy algorithms*.

> (b) *Briefly describe an advantage of using MHT over GNNSF.*

MHT, on the other hand, creates hypotheses for future data points and updates all the assignments-thus-far at every time step. This renders MHT extremely computationally costly, as the computational cost grows on the same order as the number of hypotheses does — which is usually exponential.