

CSE541 - Computer Vision

Weekly Report 2

**Improvising Object Tracking Algorithm SORT for Long-Term Trajectory Extraction**

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### We studied some state-of-the-art SORT algorithms. We tried to understand their approach and performance. Based on that we made these pointers:

### **BoT-SORT (Robust Associations Multi-Pedestrian Tracking)**

### **Implementation:** Leverages the SORT (Simple Online and Realtime Tracking) framework with modifications:

### - Employs a robust gating function based on Mahalanobis distance and a novel confidence-based score to handle challenging scenarios like occlusions and identity switches.

### - Introduces a "tracklet manager" to maintain short-lived tracks and facilitate re-integration into longer tracks when conditions improve.

### - Optimizes association using the Hungarian algorithm for efficiency.

### **Accuracy and Performance:** Achieves high MOTA (Multiple Object Tracking Accuracy) and IDF1 (Identification F1) scores on benchmark datasets, demonstrating effectiveness in real-world applications. Outperforms other SORT derivatives like StrongSORT in terms of HOTA (Multiple Object Tracking Accuracy Under Large Displacement).

### **Deep OC-SORT (Multi-Pedestrian Tracking by Adaptive Re-Identification)**

### **Implementation:** Builds upon OC-SORT (Observation-Centric SORT) [2] by introducing:

### - An adaptive re-identification network that dynamically adjusts its parameters based on track confidence scores, improving accuracy for low-confidence tracks.

### - A new loss function tailored for multi-object tracking.

### - A spatial re-scoring mechanism to refine bounding boxes, enhancing localization accuracy.

### **Accuracy and Performance:** Delivers competitive performance on MOT benchmarks, particularly excelling in scenarios with low-quality images or occlusions. It showcases superior IDF1 scores compared to StrongSORT.

### **StrongSORT**

### **Implementation:** Enhances the DeepSORT tracker [7] by:

### - Utilizing a more comprehensive loss function to address identity switches and false positives.

### - Incorporating online re-identification training.

### - Introducing a classification-based gating mechanism for improved association.

### **Accuracy and Performance:** Demonstrates strong results on benchmark datasets, exhibiting balanced performance across MOTA, IDF1, and HOTA metrics. It strikes a good balance between accuracy and computational cost.

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### **OC-SORT (Observation-Centric SORT)**

### **Implementation:** Offers a novel SORT variant that:

### - Represents tracks as observations (bounding boxes and appearance features) rather than Kalman filter states.

### - Employs a new gating function based on Mahalanobis distance and appearance similarity.

### - Leverages the Hungarian algorithm for efficient association.

### **Accuracy and Performance:** Shows promising results on challenging datasets, particularly in handling scenarios with occlusions and rapid appearance changes. It demonstrates competitive HOTA scores.

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### **Addressing Shortcomings:**

### **Comparative Analysis:** While quantitative comparisons are available on benchmark datasets, a more extensive analysis across diverse scenarios would be beneficial to fully understand the strengths and limitations of each approach.

### **Generalizability and Adaptability:** Further evaluation on real-world deployments with varying conditions and application requirements is necessary to assess their generalizability and adaptability.

### **Computational Efficiency:** Although comparisons exist, deeper exploration of the trade-off between accuracy and computational cost is crucial for resource-constrained environments.

### Overall, these SORT-based trackers exhibit promising potential for various multi-object tracking tasks. The choice of model should be based on the specific application's requirements, considering factors like accuracy, robustness, computational efficiency, and ease of deployment.

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### **Conclusion:**

### SORT offers a robust solution for real-time object tracking in computer vision applications, providing developers with effective tracking capabilities.

### **References:**

1. Aharon, N., Orfaig, R., & Bobrovsky, B. (2022). BoT-SORT: Robust Associations Multi-Pedestrian Tracking. ArXiv, abs/2206.14651.
2. Maggiolino, Gerard & Ahmad, Adnan & Cao, Jinkun & Kitani, Kris. (2023). Deep OC-Sort: Multi-Pedestrian Tracking by Adaptive Re-Identification. 3025-3029. 10.1109/ICIP49359.2023.10222576.
3. Y. Du et al., "StrongSORT: Make DeepSORT Great Again," in IEEE Transactions on Multimedia, vol. 25, pp. 8725-8737, 2023, doi: 10.1109/TMM.2023.3240881
4. Cao, J., Pang, J., Weng, X., Khirodkar, R., & Kitani, K. (2023). Observation-centric sort: Rethinking sort for robust multi-object tracking. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (pp. 9686-9696).