Speeding Up Semi-Supervised On-line Boosting for Tracking*

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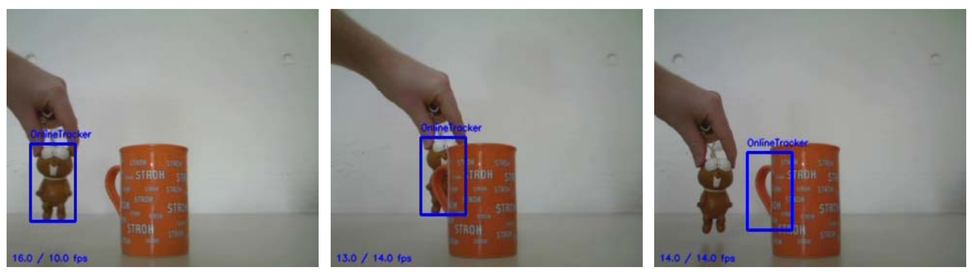
Abstract Recently, object tracking by detection using adaptive on-line classifiers has been investigated. In this case, the tracking problem is reduced to the discrimination of the current object view from the local background. However, on-line learning may introduce errors, which causes drifting and let the tracker fail. This can be avoided by using semi-supervised on-line learning (i.e., the use of labeled and unlabeled training samples), which allows to limit the drifting problem while still staying adaptive to appearance changes. In particular, this paper extends semi-supervised on-line boosting by a particle filter to achieve a higher frame-rate. Furthermore, a more sophisticated search-space sampling, and an improved update sample selection have been added.

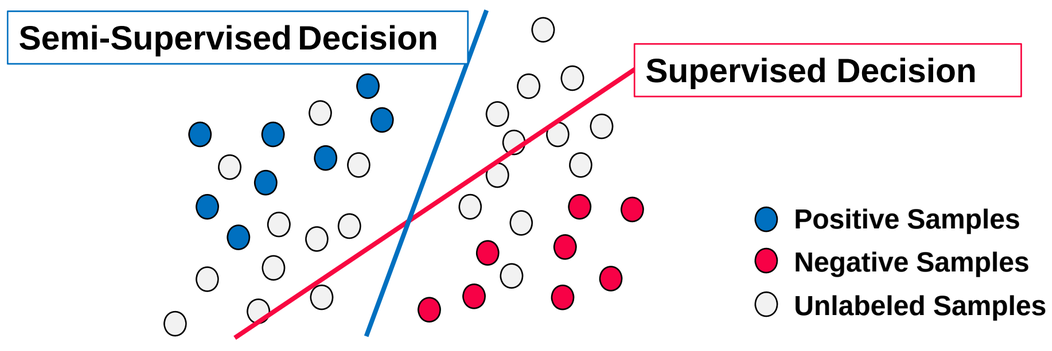
Motivation

On-line supervised learning within Tracking-by-Detection may introduce errors into the object model and cause drifting due to the unsupervised nature of the tracking task.



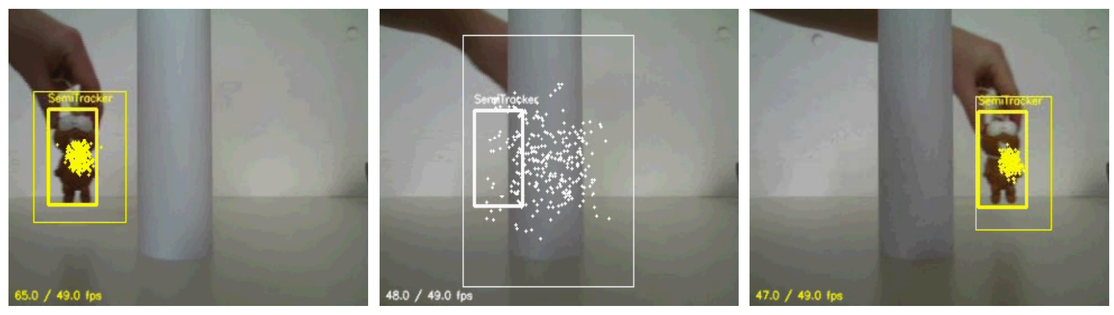
Semi-Supervised Learning

Include unlabeled data into training set to improve performance of resulting classifier (use cluster and manifold assumption).

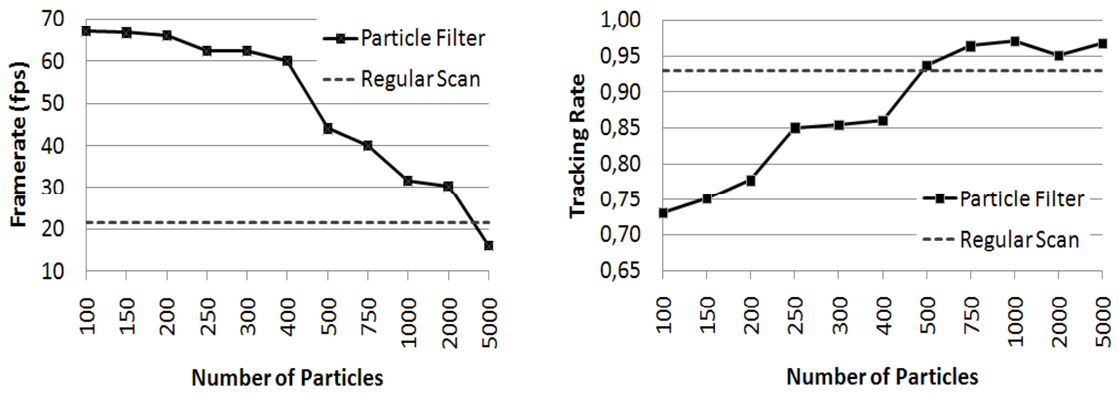


Particle Filtering

We are using the particle filter to estimate the objects location. The particle weights are set according to the confidence of the learned classifier at the particle locations.

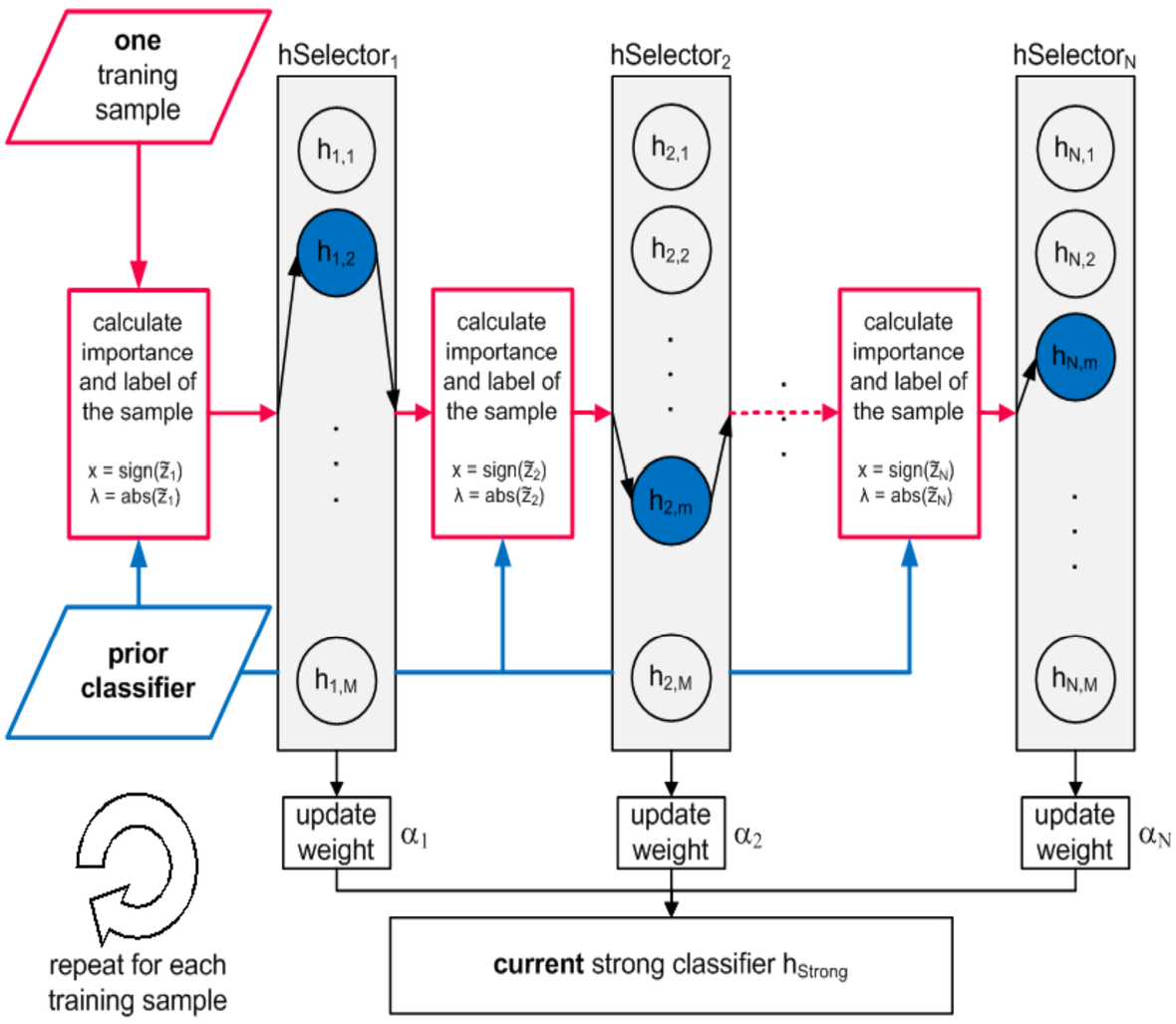


- Dense sampling at interesting locations
- Motion model helps handling temporary occlusions.
- We achieve same tracking rate with a sample reduction of 90%.



Semi-supervised On-line Boosting (SSOB)

On-line Boosting incrementally selects suitable classifiers out of N classifier pools and combines them to a strong ensemble H_{Strong}.

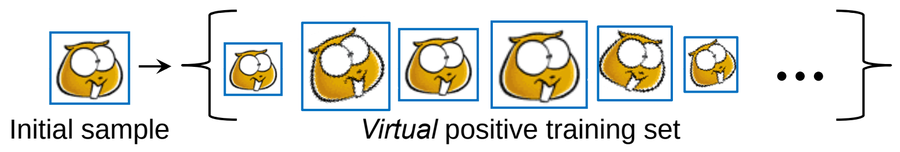


The label and the weight of processed training samples depend on the combined decision of a prior classifier H^P and the on-line learned classifier H_n:

$$\tilde{z}_n(x) = \tanh\left(H^P(x)\right) - \tanh\left(H_{n-1}(x)\right)$$

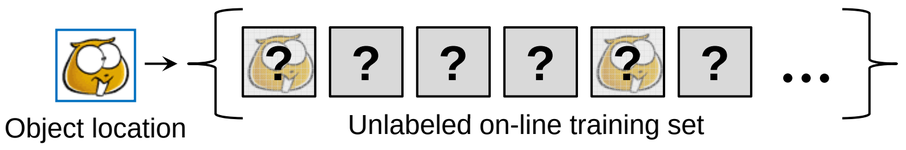
One-Shot Training of Prior Classifier

Create virtual samples that simulate natural behaviour of the object.



Update Patch Selection

Evaluated different methods for patch selection and their influence on tracking performance.



Results

Tracking the Dudek-Sequence (from Jepson, Fleet, and El-Maraghi)

Tracking Sylvester (from David Ross)

Conclusion

- Label noise and jitter cause drifting
- SSOB limits drifting but also adaptivity
  - ► *Stability Plasticity Dilemma*

References

1. M. Godec, H. Grabner, C. Leistner, H. Bischof, *Speeding Up Semi-Supervised Boosting for Tracking*, AAPR Workshop 2009
2. H. Grabner, C. Leistner, H. Bischof, *Semi-Supervised On-line Boosting for Robust Tracking*, ECCV 2008

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