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Modulated Training of Cascaded Ensembles

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Outline

- Introduction
- Problem outline
- Machine learning with PSL
- Training with positive sample bootstrapping
- Experimental results and limitations
- Adaptive learning with PSL-like frameworks
- Concluding remarks
- References





Ensemble Based Learning

- Trains multiple classifiers
- Combines collective decisions into a single classification
- Underlying principle: combined decision better than that of any individual expert
- Key components:
 - Ensemble diversity
 - Methods to combine decisions

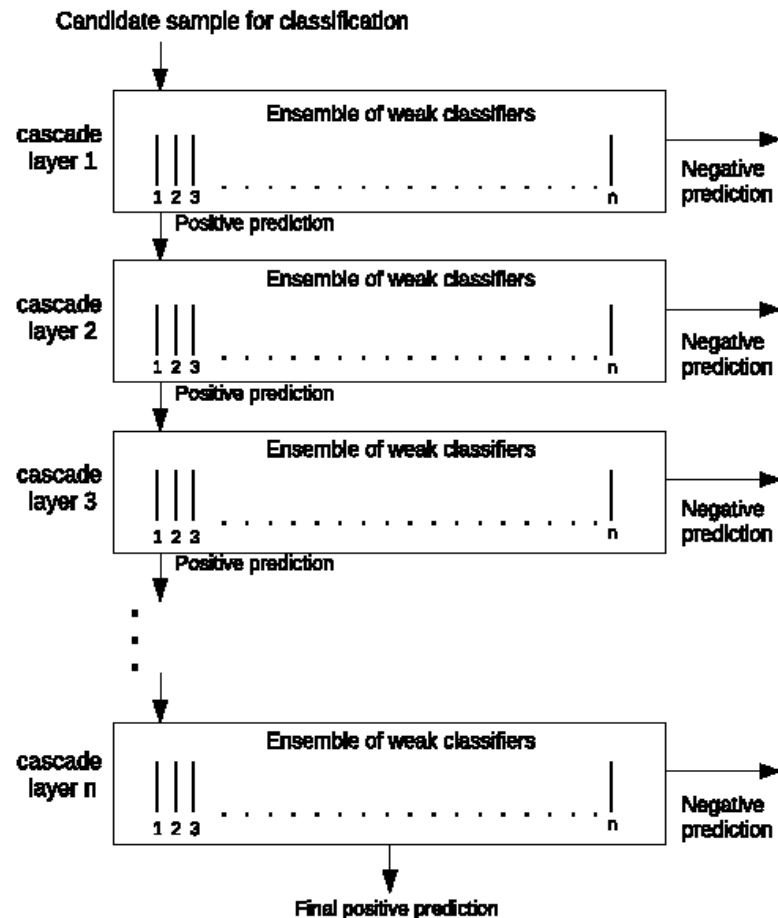




Cascades of Boosted Ensembles

- Weak classifiers arranged into layers
- Each layer classifies samples of increasing complexity
- Enables real-time classification
- Facilitates training with large negative datasets
- Modularization and tractability

Viola-Jones Training Architecture





Cascades of Boosted Ensembles

- Disadvantages
 - Training speed
 - Slow convergence to layer targets
 - Positive dataset size limitation
 - Cascade optimization issues

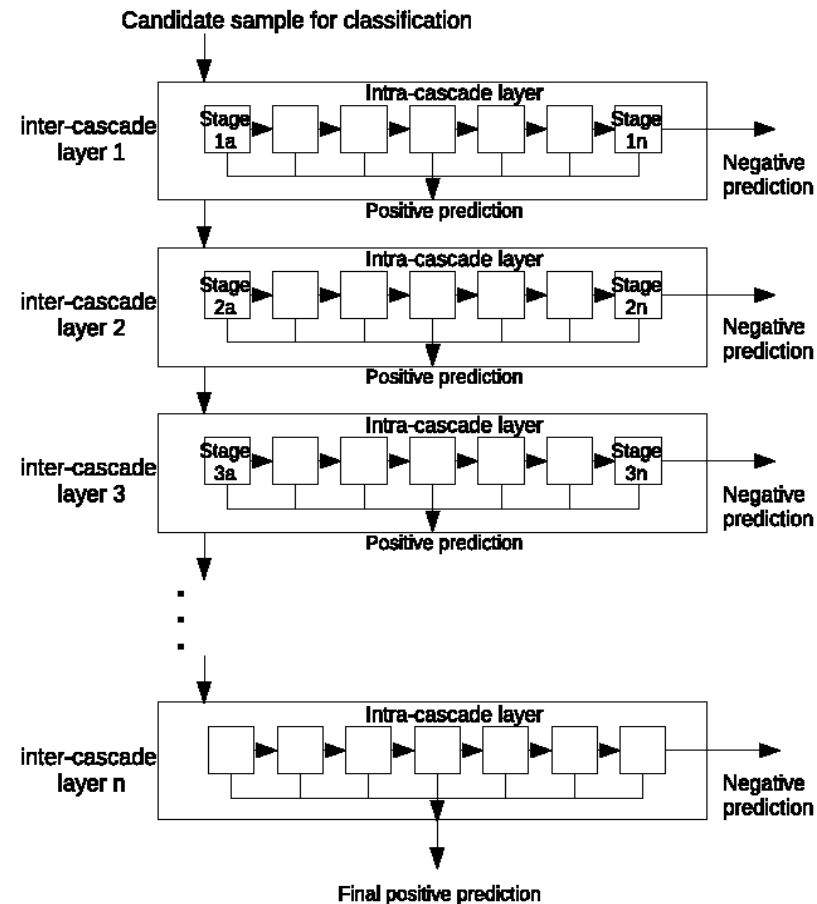




PSL Training Structure

- Parallel strong classifiers within the same layer
- Quasi dual-cascaded structure
- Faster convergence to layer targets
- Overall training runtime reduction
- Simplified optimization

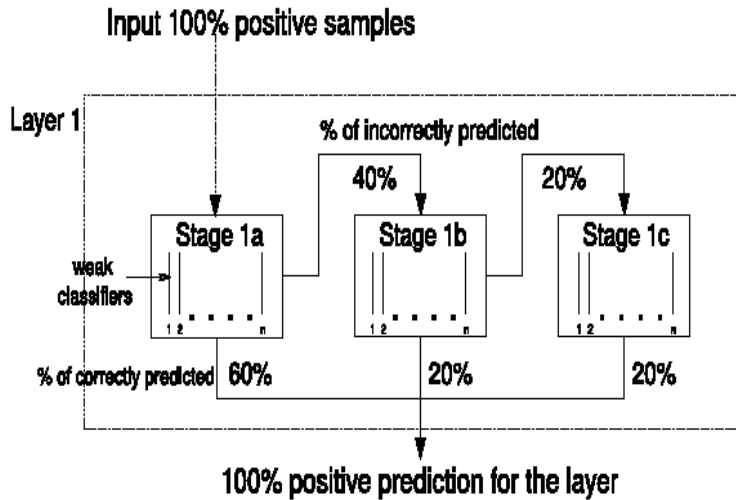
PSL Training Architecture



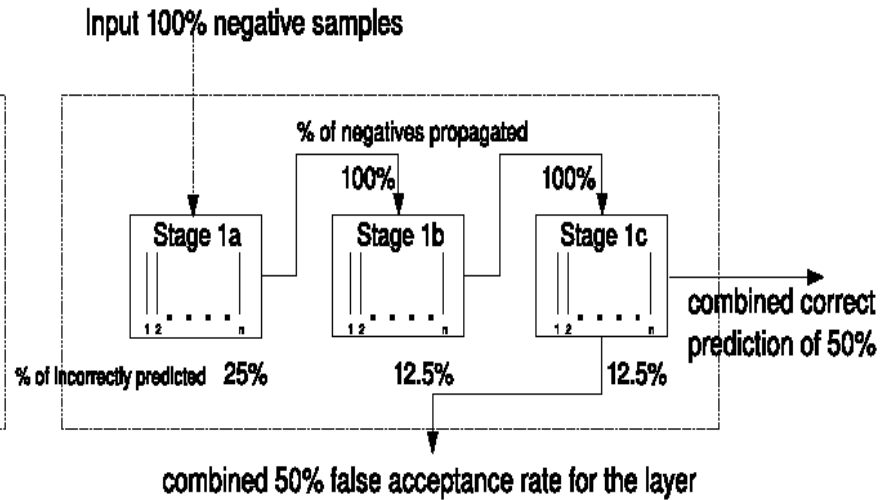


PSL Training Structure

Propagation of Positive Samples at Training



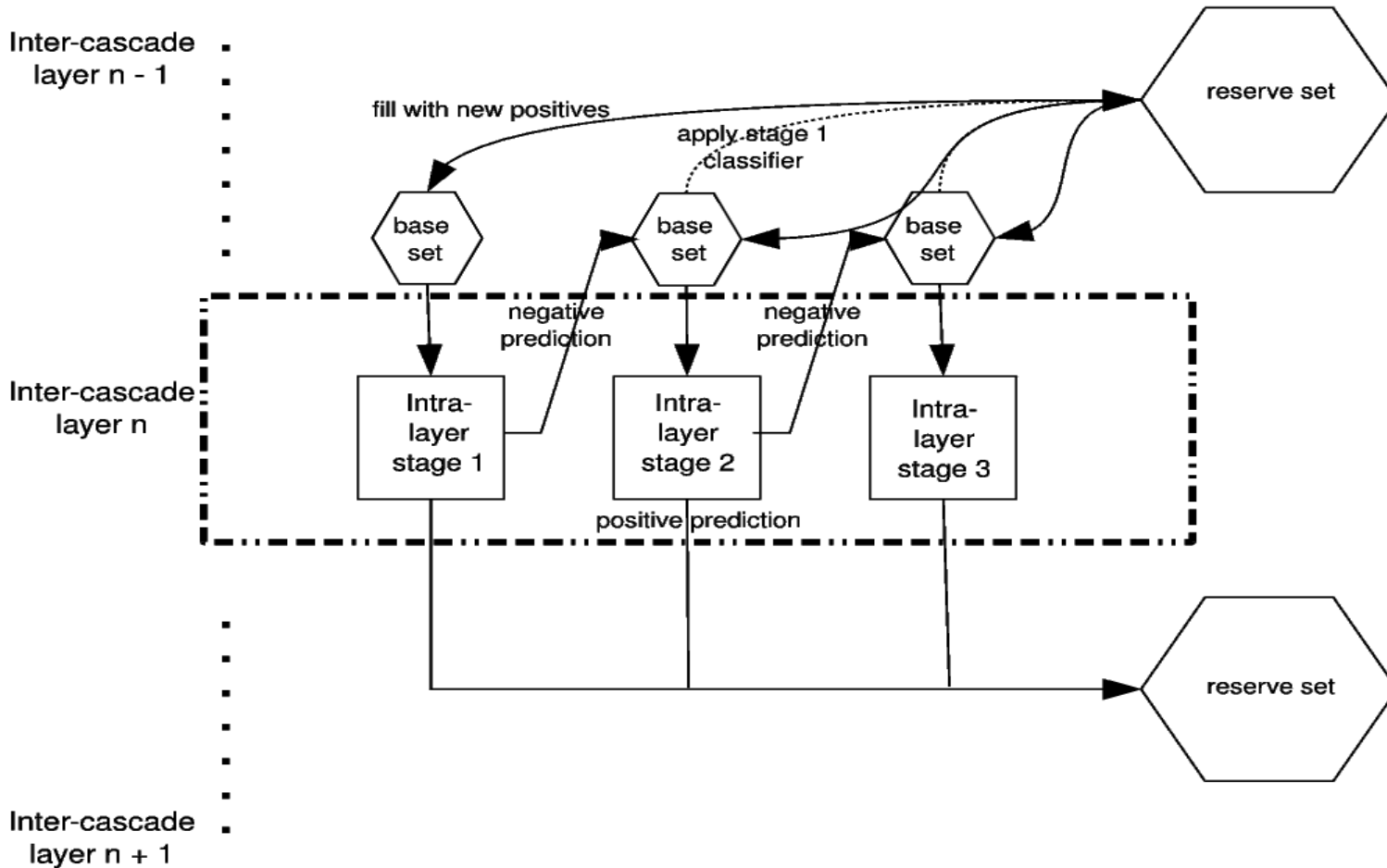
Propagation of Negative Samples at Training





Bootstrapping Positives

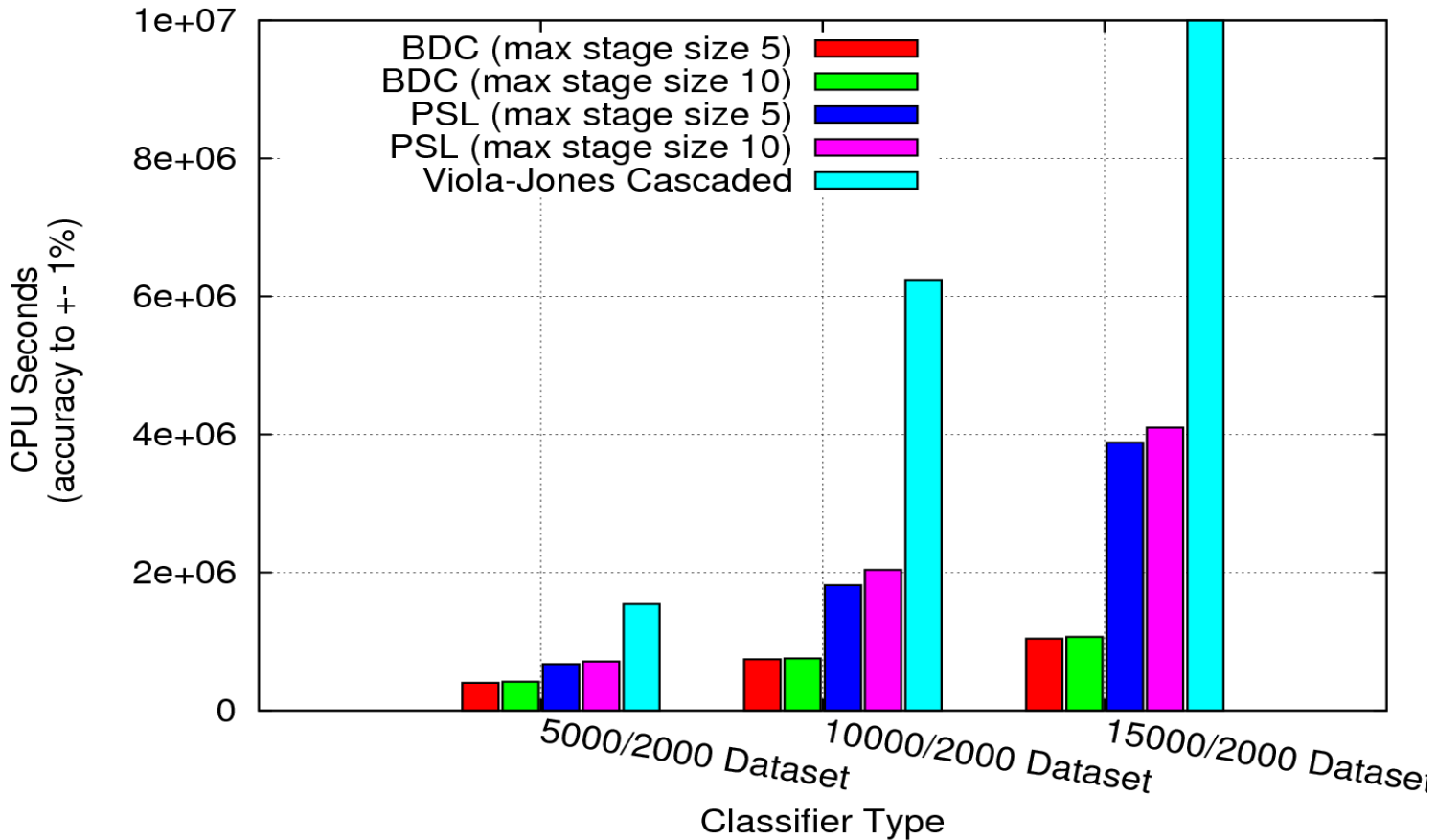
Bootstrapping Procedure in the BDC Framework





Bootstrapping Positives - Results

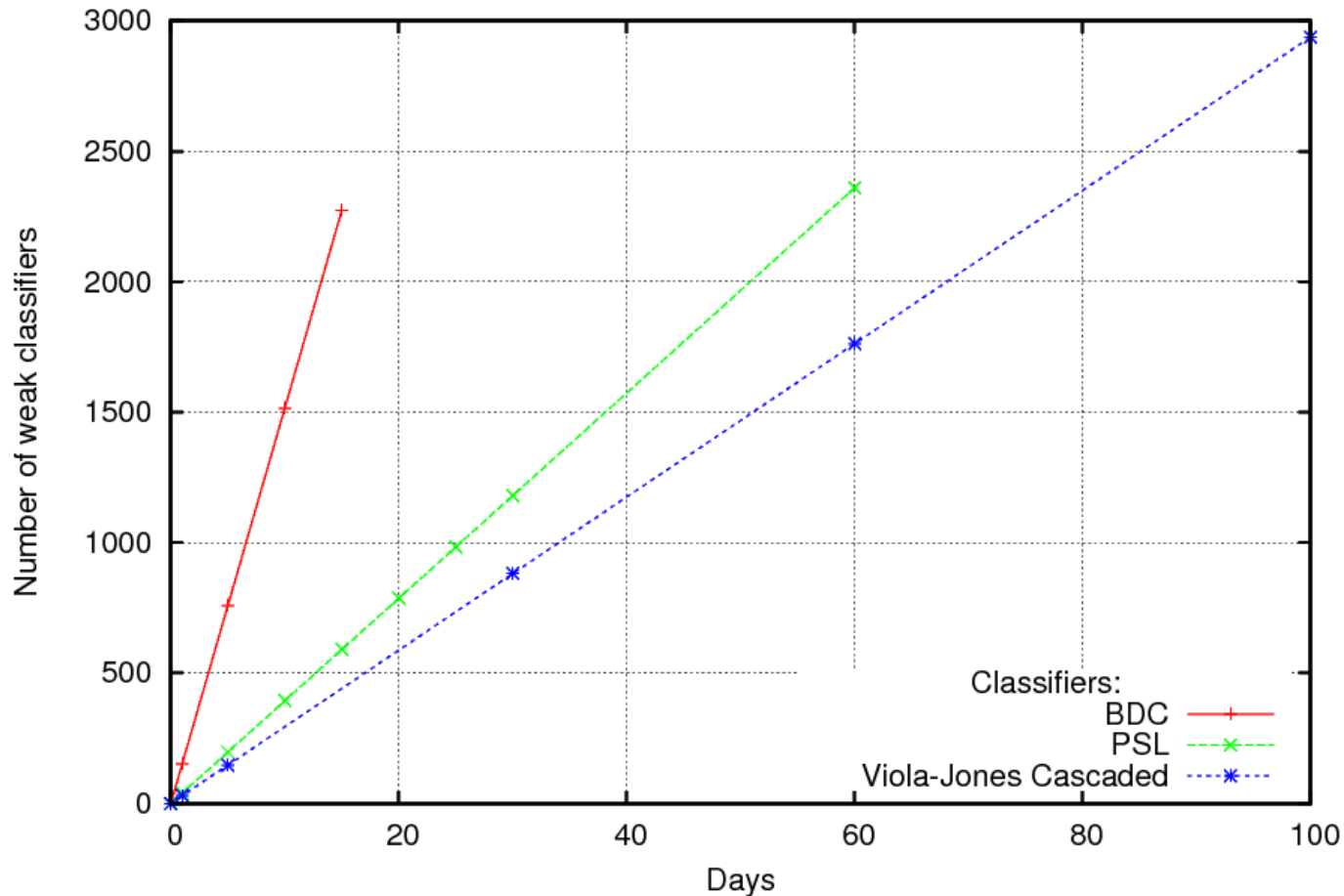
Training Runtimes





Bootstrapping Positives - Results

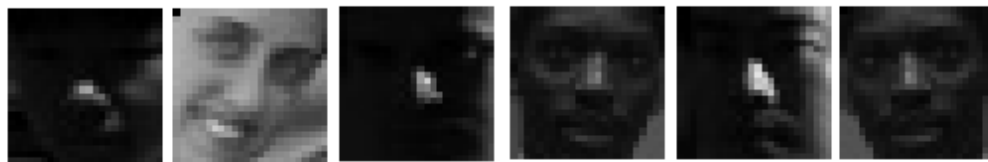
Rate of Weak Classifier Generation





Bootstrapping Positives - Overfitting

Example of samples trained in initial intra-layer stages

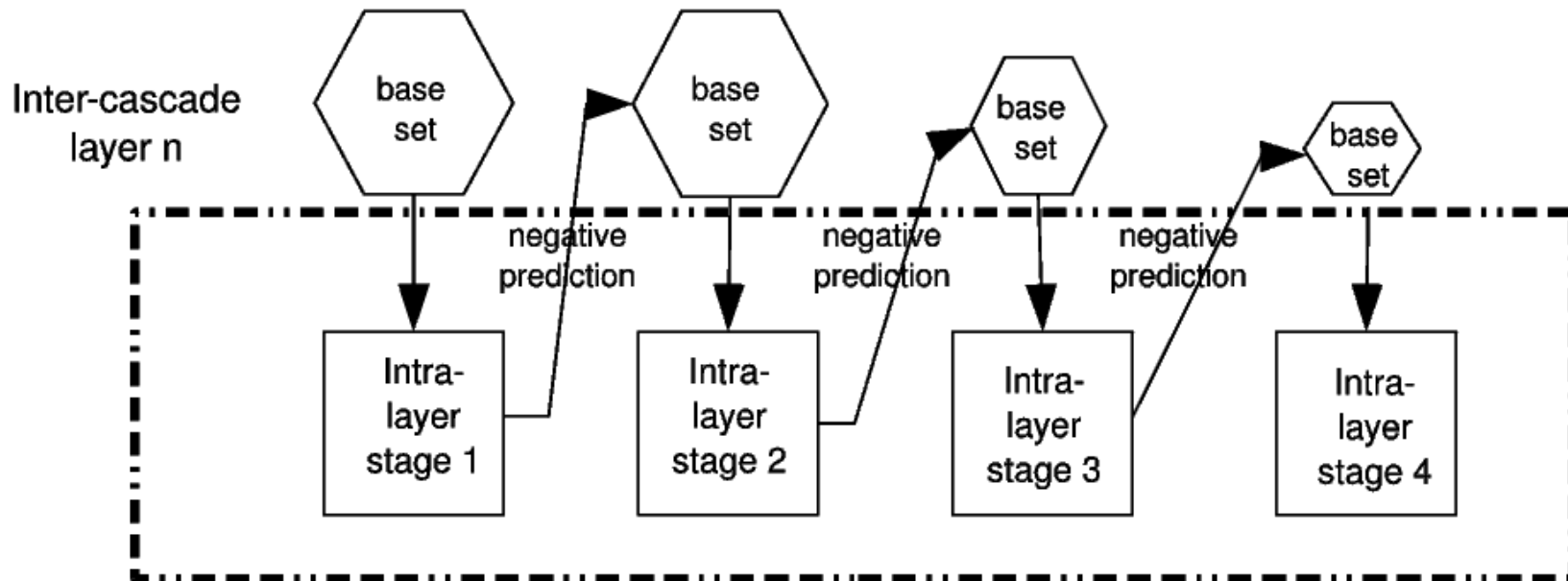


Samples trained in trailing intra-layer stages





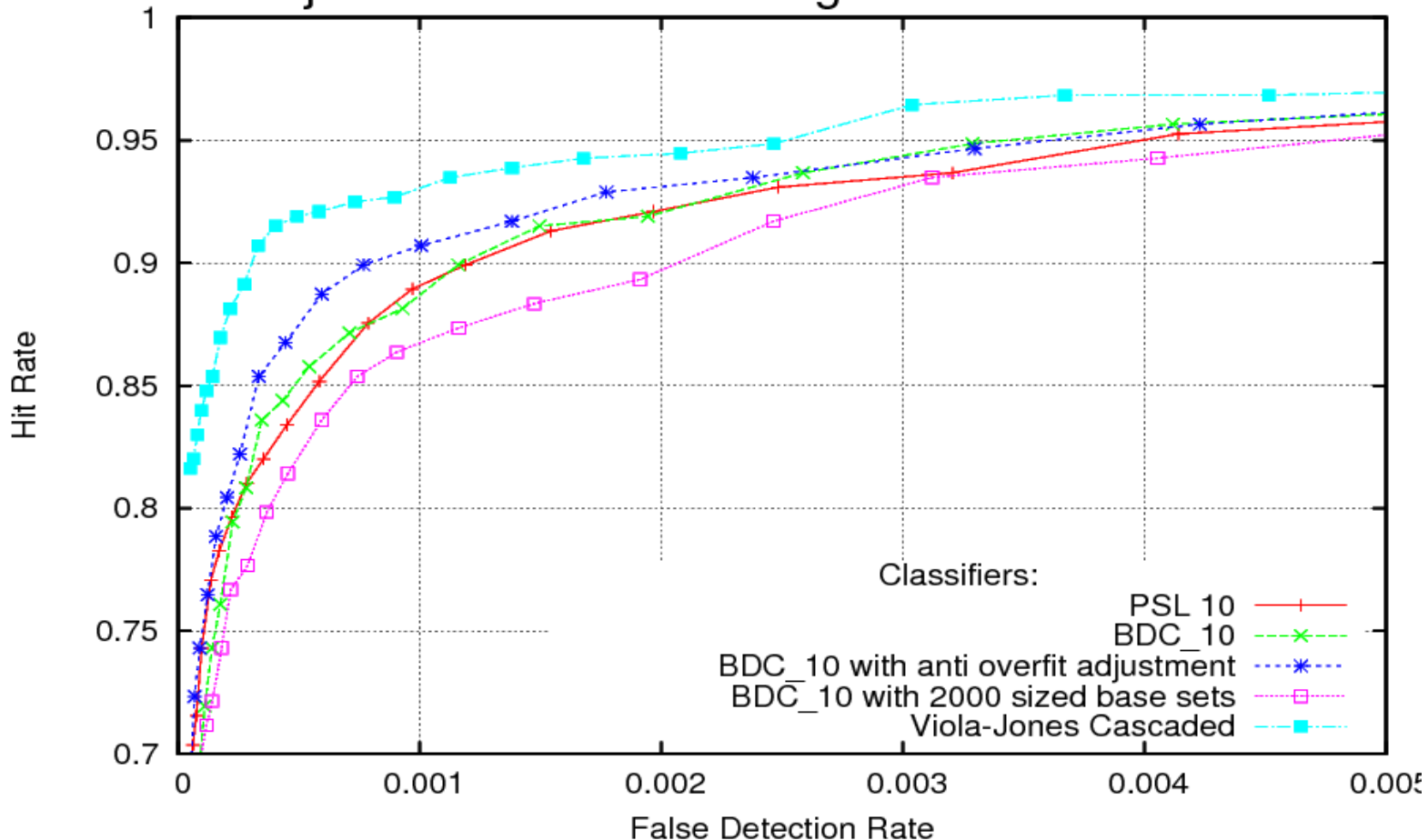
Bootstrapping Positives - Overfitting





Bootstrapping Positives - Results

ROC Graph Comparing BDC Classifiers with Adjustments for Overfitting for datasets of 10000





Adaptive Learning with PSL

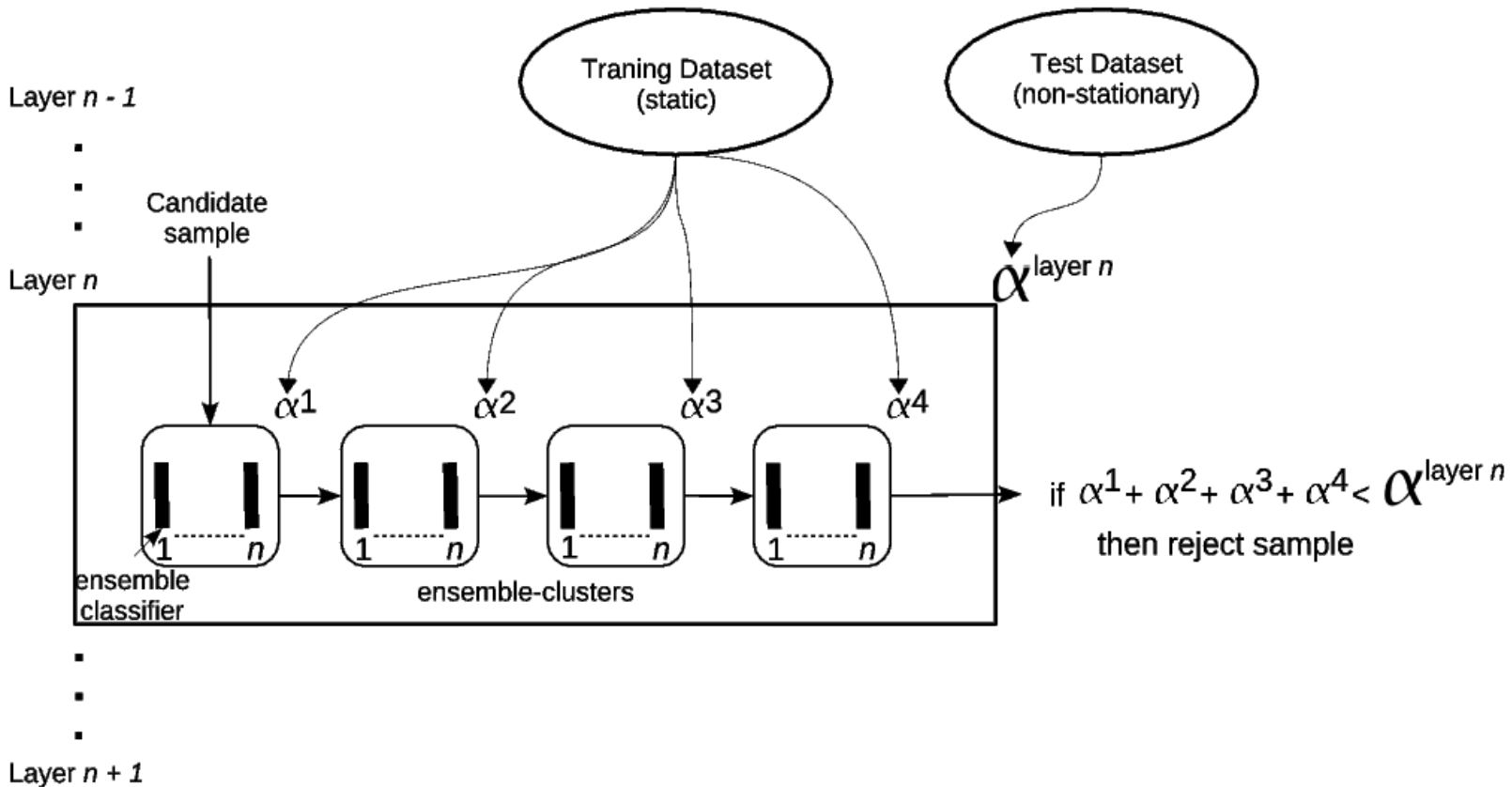
- Statically trained classifiers insufficient
- Concept drift
 - Unpredictable changes in the underlying distribution of data
 - Abrupt or gradual
- Adaptability requirements:
 - Timely
 - No access to prior datasets
 - Balance between *plasticity* and *stability*





Adaptive Learning with PSL

Concept Learning Framework





Conclusion

- Cascades of ensembles can be modularized
- Modularization introduces tractability to training
- The new framework enables bootstrapping of positive samples
- Scope for extending for effective concept-drift handling and incremental learning





References (partial)

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Questions?

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Thank you!

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