**Ilastik Profiling Report**
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Cross-validation tests with varying numbers of trees and different features were conducted to optimize the running time of Ilastik. Five different data sets were used to run these tests, with each case containing 2 or 3 videos. Fifty frames were labeled for each video and used as ground-truth data for cross-validation. In figure 1 we can observe the classification results with different number of trees for the case of Virilis A larvae:
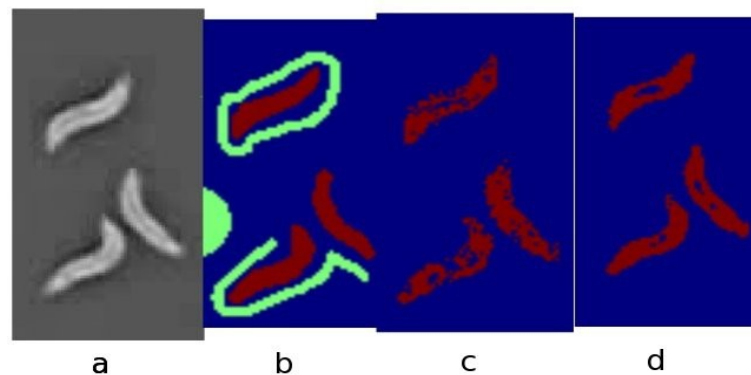


Figure 1: a) Frame screen-shot b) Ground-truth labels c) Prediction with 1 tree d) Prediction with 50 trees

In the following sections each feature is represented by an abbreviation, followed by sigma (eg. *GS(10.0)* means Gaussian smoothing with sigma 10.0):

| | |
|---|---|
| Gaussian Smoothing | GS |
| Laplacian of Gaussian | LG |
| Gaussian Gradient Magnitude | GGM |
| Difference of Gaussians | DG |
| Structure Tensor Eigenvalues | STE |
| Hessian of Gaussian Eigenvalues | HGE |

**Feature Selection Test**

The objective of this test is to select the optimal features that will result in the fastest running-time while maintaining an acceptable cross-validation error.
For each case, features were removed gradually according to their importance.

Some notes on the results:
- The RF importance table is re-calculated every time a feature is removed.
- The total time corresponds to the time for feature computation plus prediction, and doesn't include training time.
- The time improvement is a comparison against the running time of the test case with all the features activated.

**Feature Selection Test**

| Test Case | Resolution (px) | CV Error (%) | Features Removed | Features Remaining | Training Time (secs) | Feature Time (secs) | Prediction Time (secs) | Total Time (secs) | Time Per Frame (secs) | Time Improvement (X Times) | Num of Feature Pixels (10%) | Foreground / Background Pixel Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alice's Courtship Bowl | 1024x1024 | 0.124 | GGM(5.0), GGM(3.5), DG(10.0) GGM(10.0), DG(0.7), HGE(0.7) STE(5.0), LG(0.7), STE(0.7) GS(3.5), DG(1.6), LG(10.0) DG(1.0), GGM(0.7), STE(10.0) GGM(1.0), STE(3.5), GS(1.0) LG(1.6), HGE(1.6), GS(5.0) HGE(1.0), HGE(10.0), LG(1.0) GS(10.0), GS(1.6), LG(5.0) GS(0.7), GGM(1.6), DG(3.5) STE(1.6), GS(0.3) | LG(3.5), HGE(3.5), DG(5.0) STE(1.0), HGE(5.0) | 19.110656 | 58.49 | 28.90 | 106.50 | 2.15 | 3.25 | 546459 | 113 |
| Alice's Fly Bowl | 1024x1024 | 0.075 | GGM(10.0), LG(0.7) GGM(3.5), LG(10.0), GGM(5.0) STE(10.0), GS(1.6), DG(0.7) DG(10.0), GS(0.7), GGM(1.6) HGE(0.7), GS(3.5), GS(1.0) LG(1.0), STE(1.0), STE(0.7) GS(10.0), STE(5.0), GGM(0.7) DG(1.0), LG(1.6), GS(5.0) GGM(1.0), HGE(10.0), STE(1.6) DG(1.6), LG(5.0), GS(0.3) HGE(1.6), HGE(1.0), HGE(5.0) DG(5.0) | STE(3.5), HGE(3.5), LG(3.5) DG(3.5) | 16.44293 | 31.59 | 29.36 | 77.39 | 1.18 | 4.5 | 704711 | 141 |
| Alice's Fly Bubble | 1024x1024 | 0.164 | GGM(5.0), LG(0.7), DG(0.7) GGM(1.0), GGM(3.5), DG(1.0) HGE(0.7), LG(1.0), HGE(1.6) DG(1.6), HGE(1.0), GGM(1.6) LG(1.6), GGM(10.0), GS(3.5) LG(3.5), GGM(0.7), STE(0.7) STE(1.0), DG(5.0), STE(1.6) STE(3.5), GS(5.0), STE(5.0) STE(10.0), HGE(3.5), DG(3.5) LG(5.0), HGE(5.0), GS(1.0) GS(0.3) | GS(0.7), GS(1.6), GS(10.0) LG(10.0), DG(10.0), HGE(10.0) | 14.50312 | 72.90 | 23.11 | 110.52 | 2.25 | 3.2 | 753950 | 44 |
| Rivera's Larvae | 480x640 | 0.435 | DG(0.7), DG(10.0) LG(0.7), GS(0.3), GS(1.0) DG(5.0), LG(10.0), GGM(1.6) LG(5.0), GGM(3.5), GS(0.7) GS(1.6), GS(5.0), GS(3.5) GS(10.0), GGM(5.0), HGE(0.7) LG(3.5), DG(3.5), GGM(1.0) DG(1.0), LG(1.6), LG(1.0) DG(1.6), STE(3.5), STE(1.0) HGE(1.0), STE(5.0), HGE(1.6) GGM(0.7), STE(1.6) | STE(0.7), HGE(10.0), HGE(5.0) HGE(3.5), GGM(10.0), STE(10.0) | 30.811401 | 23.64 | 9.42 | 63.87 | 0.96 | 3.7 | 724720 | 149 |
| Zlatic's Larvae | 2816x2816 | 0.27 | DG(0.7), LG(0.7), HGE(0.7) DG(1.0), LG(1.0), GGM(1.0) GGM(0.7), HGE(1.0), DG(1.6) LG(1.6), GGM(1.6), GGM(3.5) HGE(1.6), STE(0.7), STE(3.5) STE(1.6), GGM(5.0), GGM(10.0) DG(3.5), STE(5.0), STE(1.0) GS(0.3), DG(5.0), HGE(10.0) GS(10.0), STE(10.0) | LG(3.5), GS(0.7), GS(5.0) GS(3.5), HGE(3.5), LG(10.0) DG(10.0), LG(5.0), GS(1.0) HGE(5.0), GS(1.6) | 299.321154 | | | | 14.50 | 2.8 | 3336278 | 97 |
| Roïan's Mice | 840x840 | 0.21 | DG(0.7), LG(0.7) HGE(0.7), STE(0.7), DG(1.6) DG(1.0), GGM(0.7), LG(1.0) GGM(1.6), GGM(1.0), HGE(1.0) LG(1.6), HGE(1.6), STE(1.0) STE(1.6), DG(3.5), LG(3.5) GGM(3.5), DG(5.0), HGE(3.5) HGE(5.0), LG(5.0), STE(3.5) GS(0.3), GGM(5.0), STE(5.0) GS(0.7), DG(10.0), STE(10.0) LG(10.0), GS(10.0) | HGE(10.0), GGM(10.0), GS(5.0) GS(1.0), GS(3.5) | 56.372587 | 57.41 | 22.63 | 136.42 | 1.19 | 3.9 | 1224050 | 32 |

## Increasing Number of Trees Test

The objective of this test is to select the number of trees that will result in the the fastest running-time while maintaining an acceptable cross-validation error.

Some notes on these tests:
- Every test ran with all the features activated.
- The time improvement is a comparison against the running time of the test case with 100 trees.
- The total time corresponds to the running time for feature computation and prediction, and doesn't include training time.

**Increasing Number of Trees Test**

| Test Case | Resolution (px) | CV Error (%) | Number of Trees | Training Time (secs) | Feature Time (secs) | Prediction Time (secs) | Total Time (secs) | Time Per Frame (secs) | Feature Time Gain | Prediction Time Gain | Total Time Gain | Foreground Pixels Num | Background Pixels Num |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alice's Courtship Bowl | 1024x1024 | 0.0854 | 20 | 67.03 | 116.4 | 46.26 | 162.66 | 3.25 | 1.02 | 1.60 | 1.19 | 4565 | 541894 |
| Alice's Fly Bowl | 1024x1024 | 0.049 | 17 | 74.32 | 118.04 | 31.63 | 149.67 | 2.99 | 1.03 | 2.18 | 1.27 | 5144 | 699567 |
| Alice's Fly Bubble | 1024x1024 | 0.14 | 11 | 76.46 | 118.06 | 31.35 | 149.41 | 2.99 | 1.01 | 2.52 | 1.32 | 16188 | 737762 |
| Rivera's Larvae | 480x640 | 0.337 | 20 | 97.45 | 70.94 | 27.72 | 98.66 | 1.97 | 0.99 | 1.52 | 1.14 | 4827 | 719893 |
| Roian's Mice | 840x840 | 0.28 | 15 | 161.58 | 78.93 | 24.94 | 103.87 | 2.08 | 1.01 | 2.27 | 1.31 | 37216 | 1186834 |

**Comparison of Running-Times for Each Feature**

The following plot compares the running-times for each feature.



Running-Time Percentage per Feature