http://poloclub.gatech.edu/cse6242

CSE6242 / CX4242: Data & Visual Analytics

# Visualization for Classification

## ROC, AUC, Confusion Matrix


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Partly based on materials by
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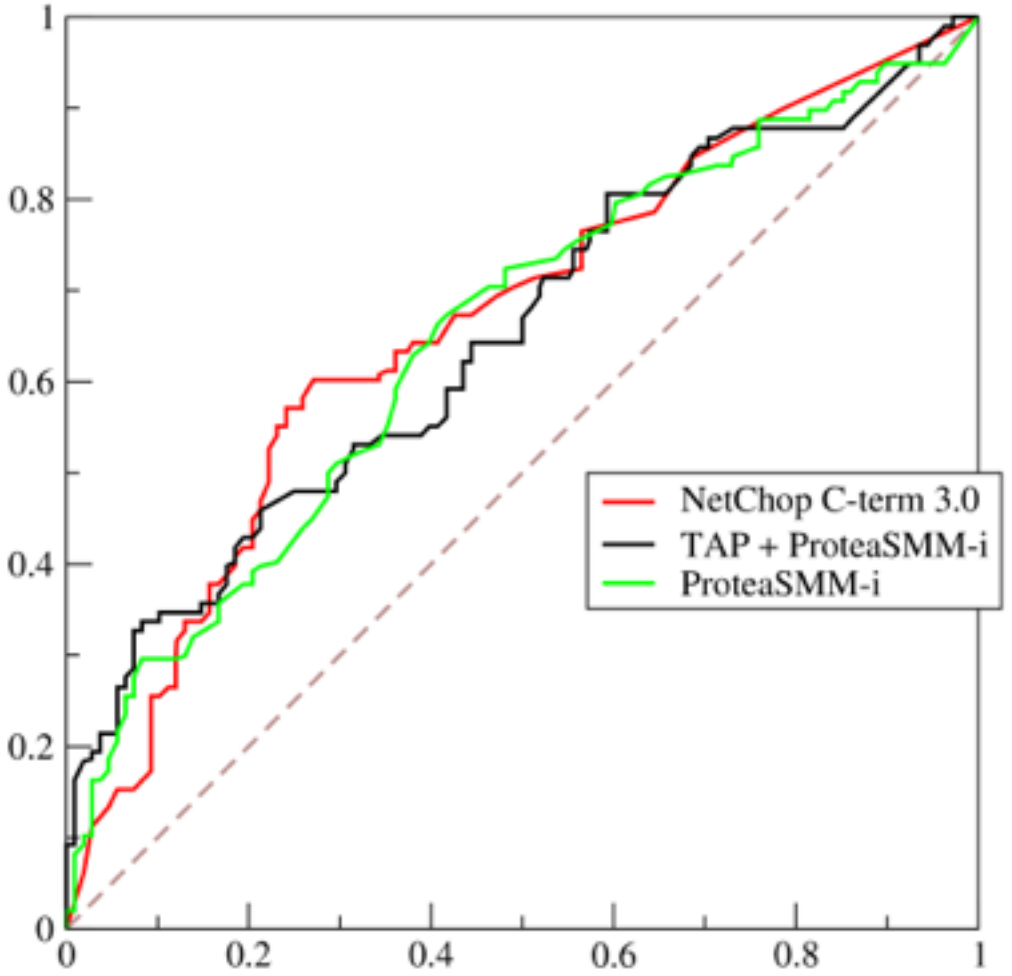
# Visualizing Classification Performance

ROC curve / cost curves

True Positive Rate



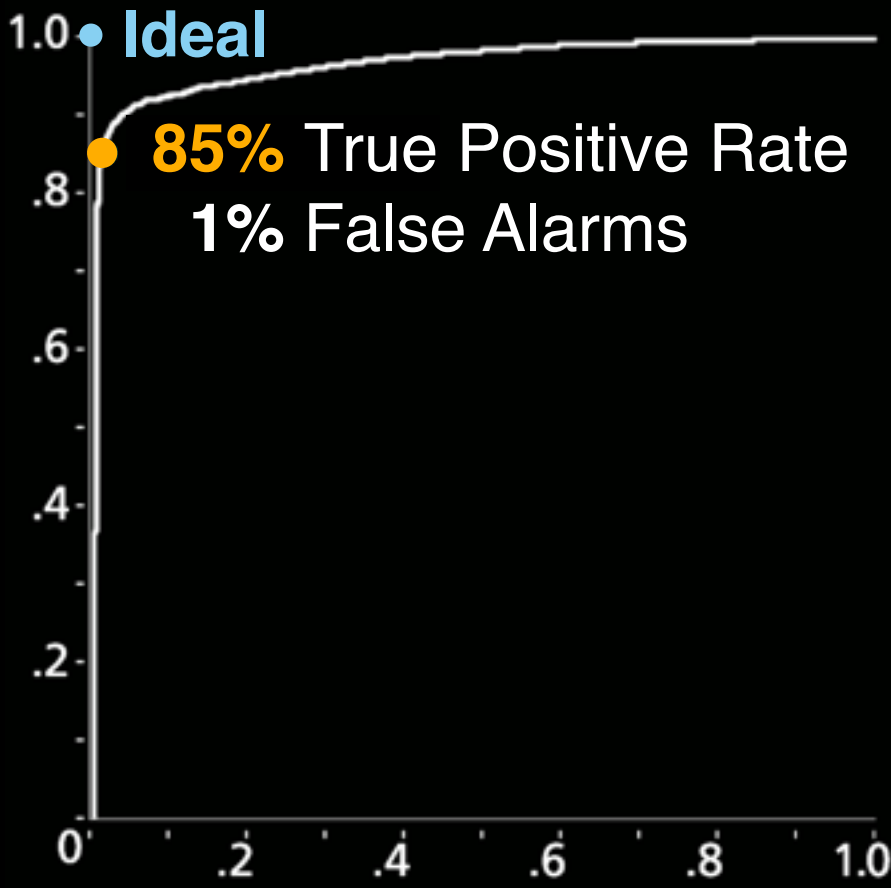

False Positive Rate

# Polonium's ROC Curve

Positive class: malware

Negative class: benign

**True Positive Rate**
% of **bad** correctly labeled




**False Positive Rate (False Alarms)**
% of **good** labeled as **bad**

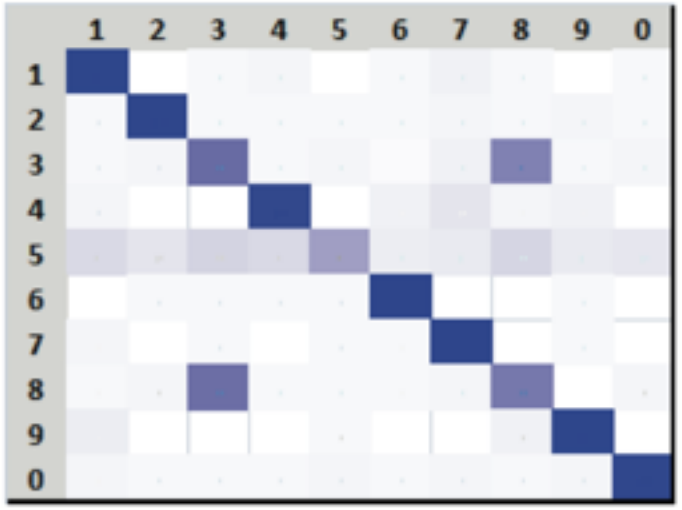
# Area Under the Curve (AUC)

# Visualizing Classification Performance

Confusion matrix

| | | Predicted class | | |
|---|---|---|---|---|
| | | **Cat** | **Dog** | **Rabbit** |
| **Actual class** | **Cat** | 5 | 3 | 0 |
| | **Dog** | 2 | 3 | 1 |
| | **Rabbit** | 0 | 2 | 11 |

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 91 | 0 | 1 | 2 | 0 | 1 | 3 | 1 | 0 | 1 |
| 2 | 1 | 89 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 1 |
| 3 | 1 | 2 | 48 | 1 | 2 | 0 | 3 | 40 | 1 | 2 |
| 4 | 2 | 0 | 0 | 83 | 0 | 3 | 7 | 2 | 3 | 0 |
| 5 | 10 | 7 | 12 | 10 | 30 | 4 | 5 | 11 | 5 | 6 |
| 6 | 0 | 1 | 1 | 1 | 1 | 95 | 0 | 0 | 1 | 0 |
| 7 | 2 | 0 | 1 | 0 | 1 | 1 | 94 | 0 | 1 | 0 |
| 8 | 1 | 2 | 47 | 1 | 1 | 1 | 2 | 43 | 0 | 2 |
| 9 | 4 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 92 | 0 |
| 0 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 87 |




Hard to spot trends and patterns

Easier

**Figure 2. Representations of confusion matrix for a handwritten digit classification task. (top) standard confusion matrix; (bottom) heat-map confusion matrix. It is much easier to identify underlying patterns in the visual representation; 3 and 8 are often misclassified as each other and 5 is misclassified as many different numbers.**



http://research.microsoft.com/en-us/um/redmond/groups/cue/publications/CHI2009-EnsembleMatrix.pdf

# Weights in combined models

Bagging / Random forests

- Majority voting

**Let people play with the weights?**

# EnsembleMatrix

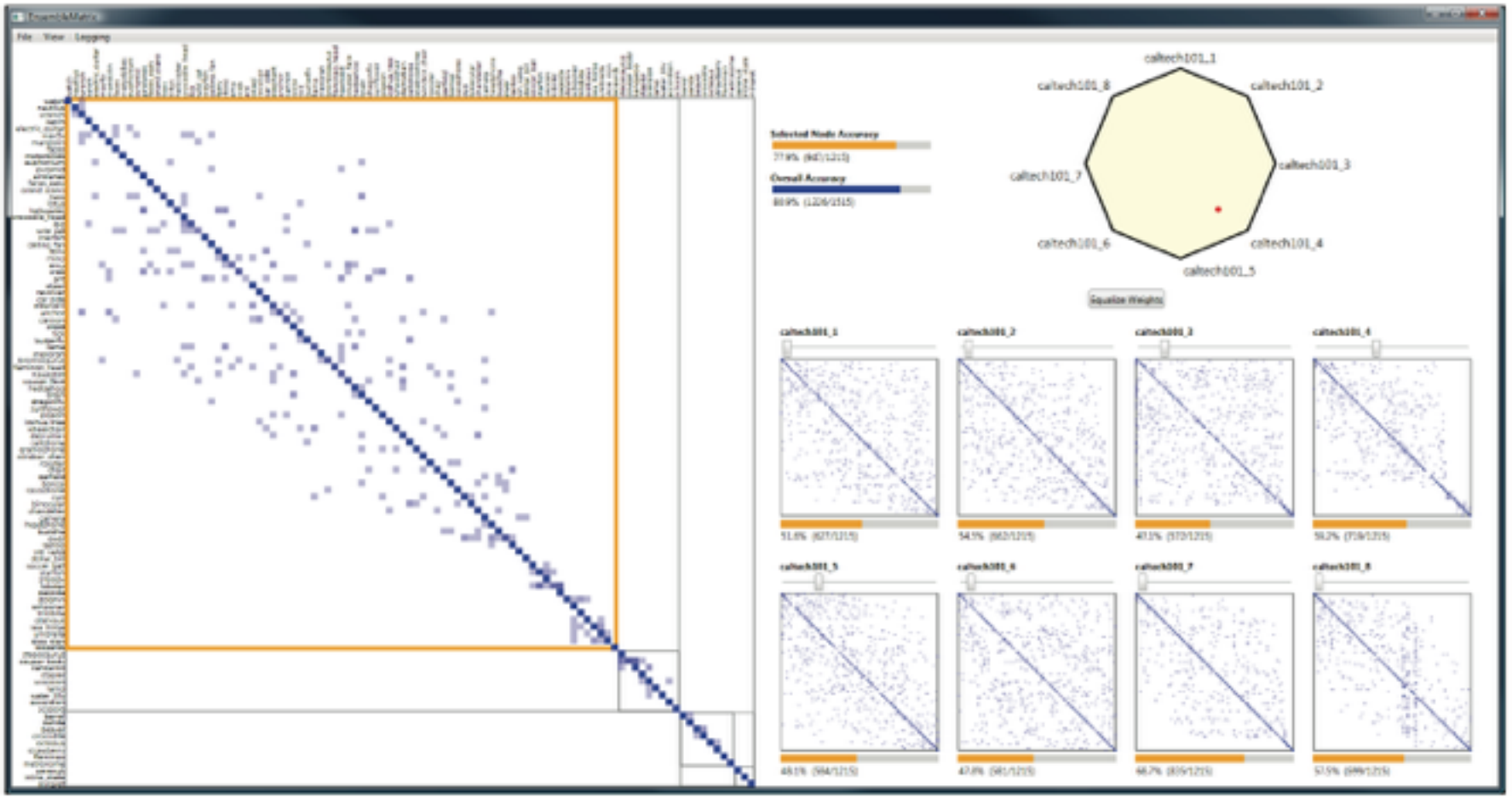



**Figure 1. Primary view in EnsembleMatrix. Confusion matrices of component classifiers are shown in thumbnails on the right. The matrix on the left shows the confusion matrix of the current ensemble classifier built by the user.**

http://research.microsoft.com/en-us/um/redmond/groups/cue/publications/CHI2009-EnsembleMatrix.pdf

# Improving performance

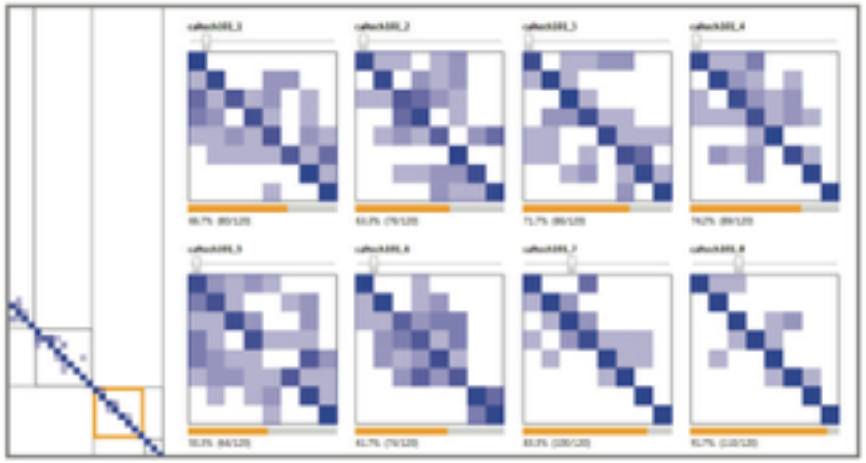


**Figure 3. After partitioning the matrix, selecting a partition, outlined in orange, causes the thumbnails to display only the data instances in that partition. The component classifiers demonstrate very different behavior in this partition, including clustering and large differences in accuracy.**

- Adjust the weights of the individual classifiers
- Data partition to separate problem areas
  - Adjust weights just for these individual parts
- State-of-the-art performance, on one dataset

http://research.microsoft.com/en-us/um/redmond/groups/cue/publications/CHI2009-EnsembleMatrix.pdf