Background Check: A general technique to build more reliable and versatile classifiers

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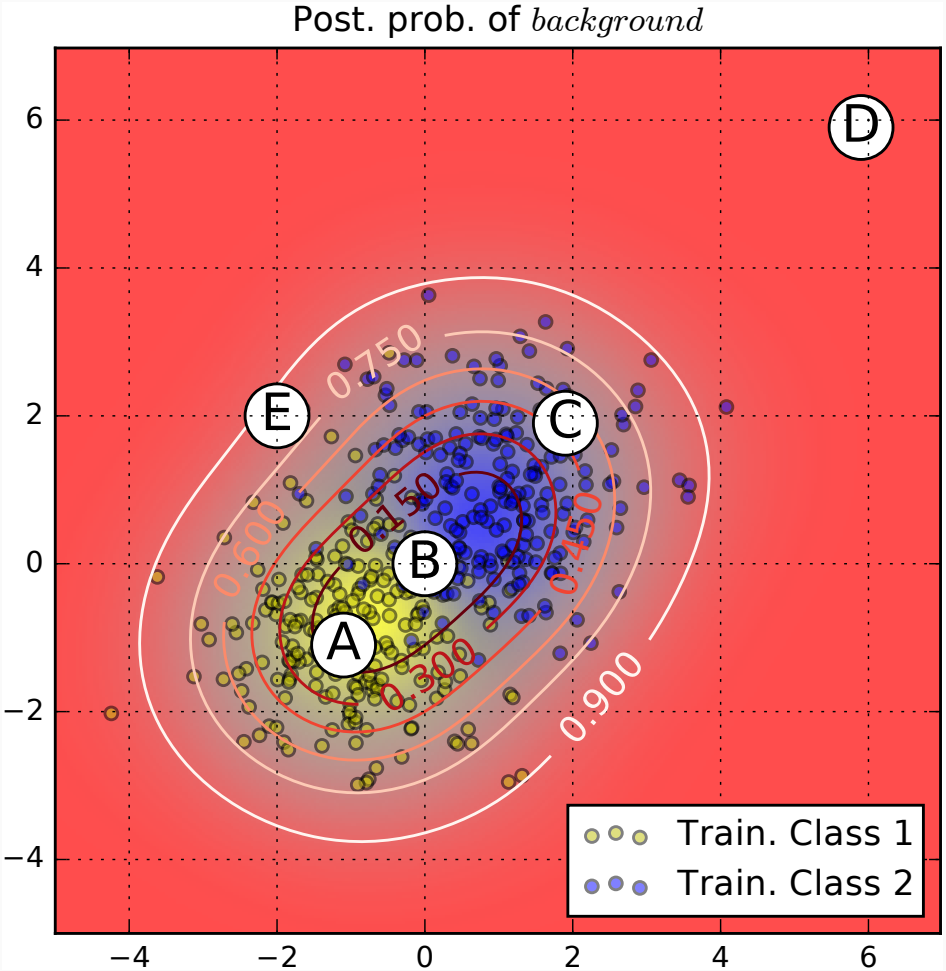
Representing uncertainty

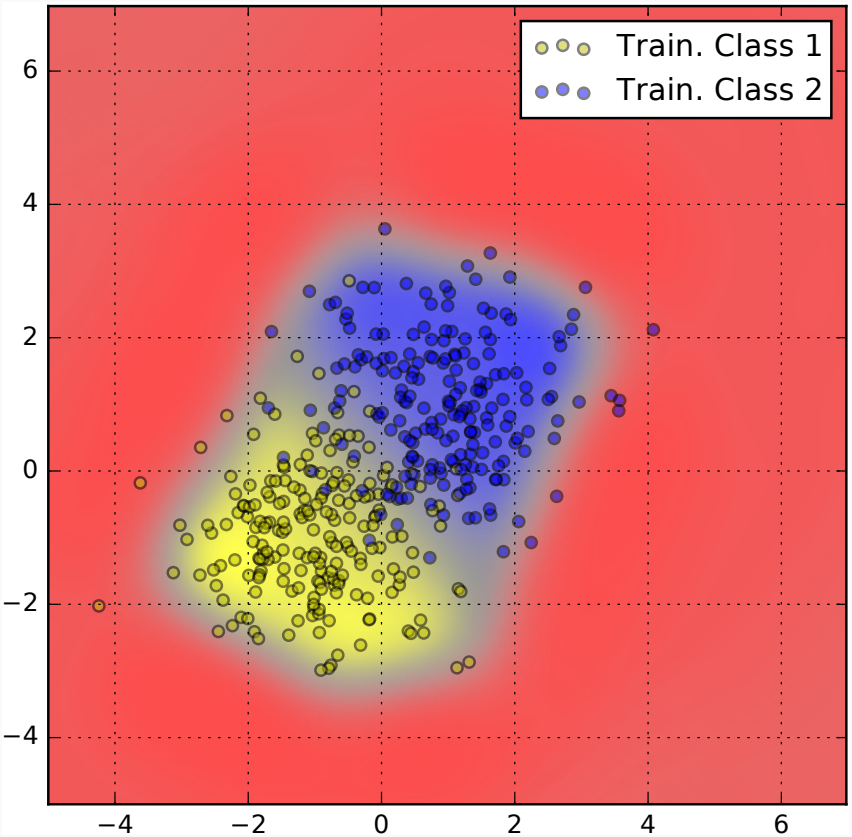
1. Cautious classification
2. Outlier detection
3. Classification with confidence

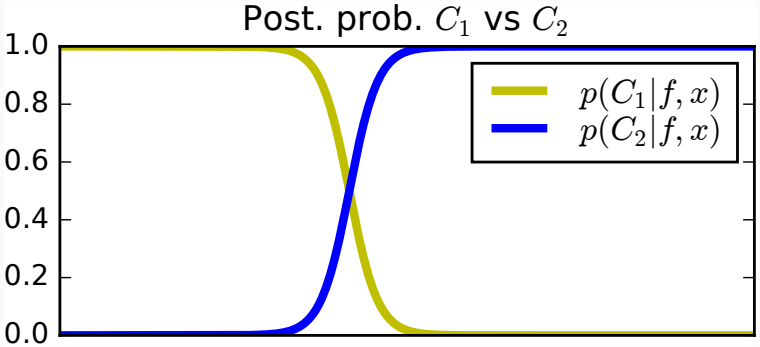
	$p(C_1\|x)$	$p(C_2\|x)$	$p(b\|x)$
A	$1 \rightarrow .9$	$.0 \rightarrow .0$	.1
B	$.5 \rightarrow .5$	$.5 \rightarrow .5$	.0
C	$.0 \rightarrow .0$	$1 \rightarrow .5$	.5
D	$.5 \rightarrow .0$	$.5 \rightarrow .0$	1
E	$.5 \rightarrow .1$	$.5 \rightarrow .1$	.8

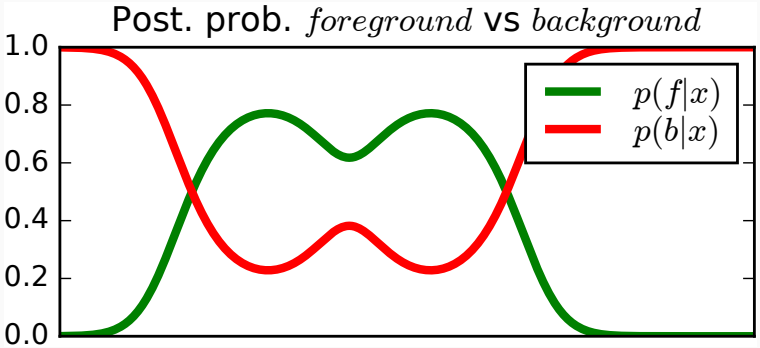


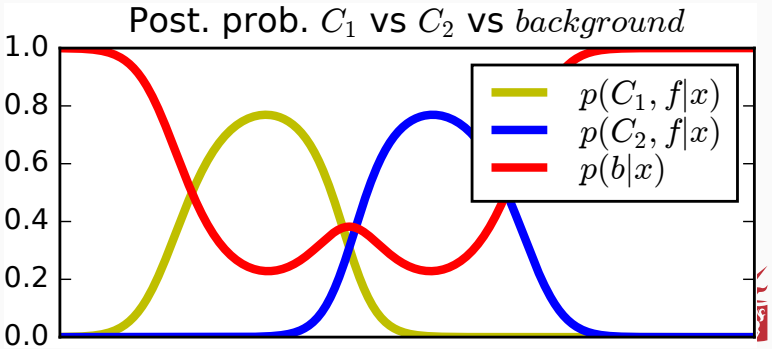
Performing Background Check

- *Discriminative* approach
  - Pre-trained classifier
  - Generate background
  - Train binary classifier









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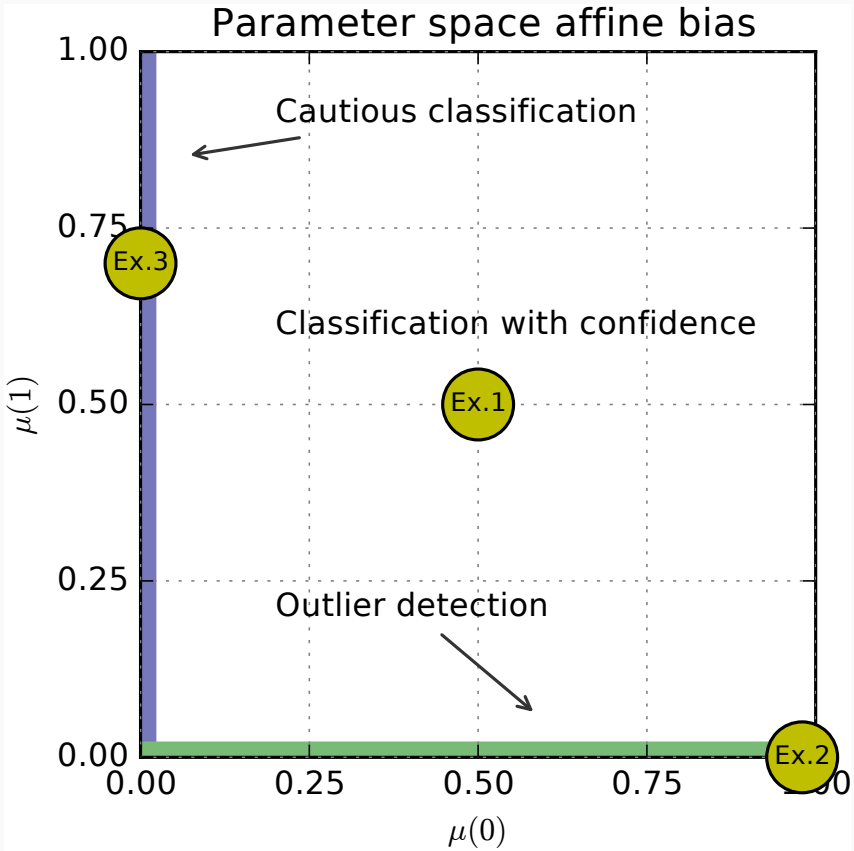
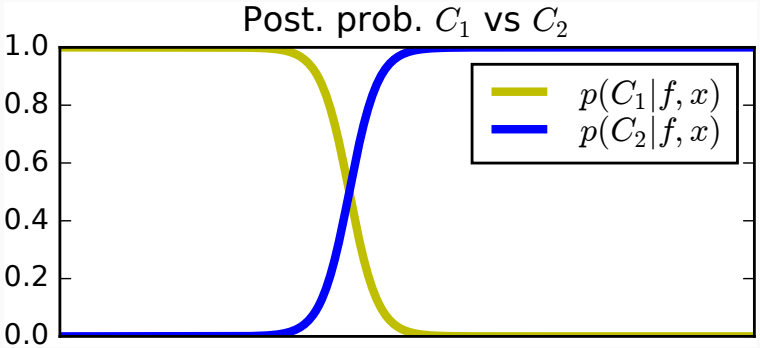
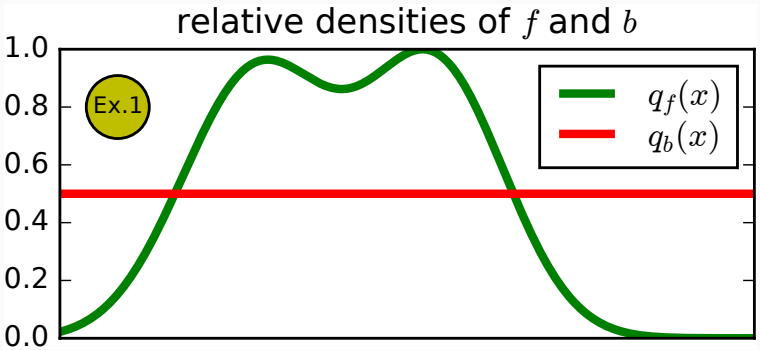
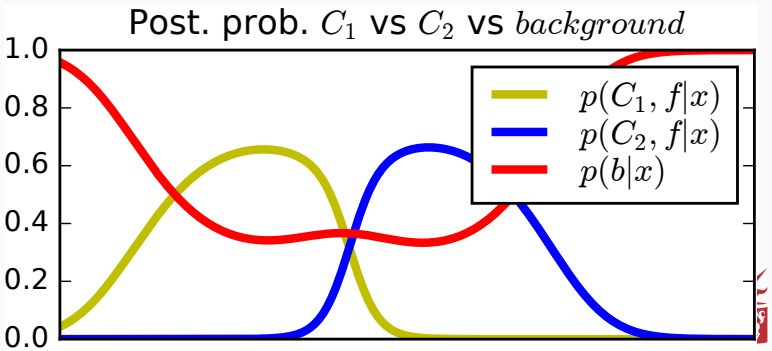
Performing Background Check

- *Familiarity* approach
  - Pre-trained classifier
  - Learn $q_f(x) \in [0, 1]$
  - Use inductive bias









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Results

- Empirical evaluation
  - 41 multiclass datasets
  - 20 times 5-fold cross-validation
  - Classification with confidence
    - *Significantly better* than [Li et al., 2014] (Wilcoxon test $p < 0.001$)
  - Outlier detection
    - *Competitive results* with two specialized methods [Tax and Duin, 2008]
- Cautious Classification is *equivalent* to Chow's rule [Chow, 1970]

Conclusion

- *General technique* to perform:
  - Cautious classification
  - Outlier detection
  - Classification with confidence
- Comparable and better results than *special purpose approaches*
- *Model agnostic*


Chow, C. (1970).
On optimum recognition error and reject tradeoff.
IEEE Transactions on Information Theory, 16(1):41–46.


Li, L., Hu, Q., Wu, X., and Yu, D. (2014).
Exploration of classification confidence in ensemble learning.
Pattern Recognition, 47(9):3120 – 3131.


Tax, D. and Duin, R. (2008).
Growing a multi-class classifier with a reject option.
Pattern Recognition Letters, 29(10):1565–1570.

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