



# Multiclass

Jordan Boyd-Graber University of Colorado Boulder LECTURE 14

Slides adapted from Rob Schapire and Fei Xia

.

#### Administrivia

- Feature Engineering HW Graded
- SVM HW
- Midterm in two weeks

## **Defining a Code Book**

- Want to decide whether a name is German, Russian, or Chinese
- Using ECOC
- What do we need first?

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- Using ECOC
- What do we need first?

Class	$b_1$	$b_2$	$b_3$	$b_4$	$b_5$	$b_6$
Chinese	0	0	0	1	0	1
German	0	1	0	0	1	0
Russian	1	0	1	1	0	1
Argentine	1	1	1	0	1	0

## **Training Data**

German Mann Goethe Grass Russian Dostoyevsky Tolstoy Gogol Chinese Cao Xueqin Lu Xun Gao Xingjian Argentine
Puig
Borges
Cortazar

5 of 8

## **Training Data**

German	Russian	Chinese	Argentine
Mann	Dostoyevsky	Cao Xueqin	Puig
Goethe	Tolstoy	Lu Xun	Borges
Grass	Gogol	Gao Xingjian	Cortazar

What are the training examples for each classifier?

#### **Training Data**

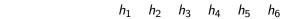
German
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What are the training examples for each classifier?



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	$h_1$	$h_2$	$h_3$	$h_4$	$h_5$	$h_6$
Mann	-	+	-	-	+	-
Goethe	-	+	-	-	+	-
Grass	_	+	_	_	+	-

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	$h_1$	$h_2$	$h_3$	$h_4$	$h_5$	$h_6$
Mann	-	+	-	-	+	-
Goethe	-	+	-	-	+	-
Grass	-	+	-	-	+	-
Dostoyevsky	+	-	+	+	-	+
Tolstoy	+	-	+	+	-	+
Gogol	+	-	+	+	-	+

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Mann	-	+	-	-	+	-
Goethe	-	+	-	-	+	-
Grass	-	+	-	-	+	-
Dostoyevsky	+	-	+	+	-	+
Tolstoy	+	-	+	+	-	+
Gogol	+	-	+	+	-	+
Cao Xue	-	-	-	+	-	+
Lu Xun	-	-	-	+	-	+
Gao Xingjian	-	-	-	+	-	+

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	$h_1$	$h_2$	$h_3$	$h_4$	$h_5$	$h_6$
Mann	-	+	-	-	+	-
Goethe	-	+	-	-	+	-
Grass	-	+	-	-	+	-
Dostoyevsky	+	-	+	+	-	+
Tolstoy	+	-	+	+	-	+
Gogol	+	-	+	+	-	+
Cao Xue	-	-	-	+	-	+
Lu Xun	-	-	-	+	-	+
Gao Xingjian	-	-	-	+	-	+
Puig	+	+	+	-	+	-
Borges	+	+	+	-	+	-
Cortazar	+	+	+	-	+	-

What about  $h_2$  vs.  $h_5$ ?

	$h_1$	$h_2$	$h_3$	$h_4$	$h_5$	$h_6$
Mann	-	+	-	-	+	-
Goethe	-	+	-	-	+	-
Grass	-	+	-	-	+	-
Dostoyevsky	+	-	+	+	-	+
Tolstoy	+	-	+	+	-	+
Gogol	+	-	+	+	-	+
Cao Xue	-	-	-	+	-	+
Lu Xun	-	-	-	+	-	+
Gao Xingjian	-	-	-	+	-	+
Puig	+	+	+	-	+	-
Borges	+	+	+	-	+	-
Cortazar	+	+	+	-	+	_

What about  $h_2$  vs.  $h_5$ ? What about  $h_4$  vs.  $h_2$ ?

#### Classification

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#### Classification

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$$\bullet \ (0,1,0,1,1,0) \rightarrow$$

#### Classification

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•  $(0,1,0,1,1,0) \rightarrow \mathsf{German}$ 

Class	$b_1$	$b_2$	$b_3$	$b_4$	$b_5$	$b_6$
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- $(0,1,0,1,1,0) \rightarrow \mathsf{German}$
- $(0,0,0,0,0,0) \rightarrow$

Class	$b_1$	$b_2$	$b_3$	$b_4$	$b_5$	$b_6$
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German	0	1	0	0	1	0
Russian	1	0	1	1	0	1
Argentine	1	1	1	0	1	0

- $(0,1,0,1,1,0) \rightarrow \mathsf{German}$
- $(0,0,0,0,0,0) \rightarrow ???$

#### **Bottom Line**

- Understand what your algorithm is doing when you ask it to multiclass
- Features and training imbalance matter more than ever
- Debugging is often easier if you binarize the problem