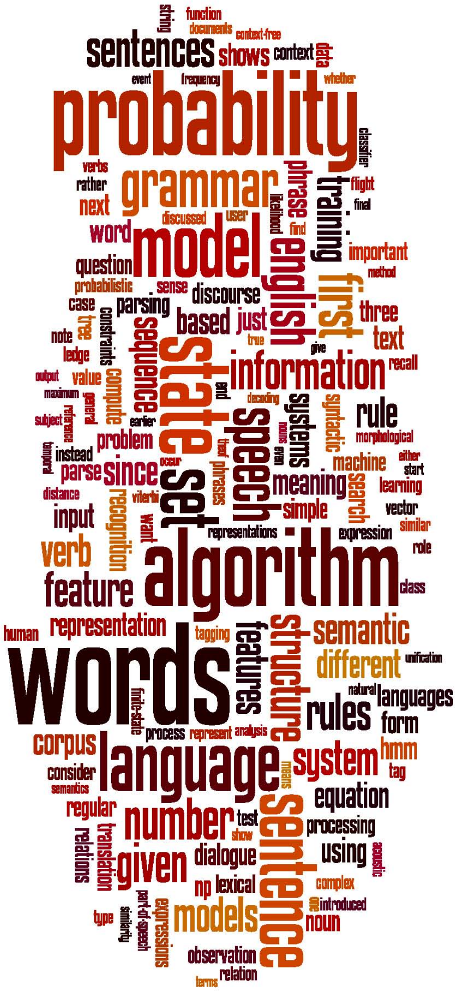

Feature Overlap/ Feature Interaction

How overlapping features work in maxent models

Feature Overlap

- Maxent models handle overlapping features well.
- Unlike a NB model, there is no double counting!

Empirical

	A	a
B	2	1
b	2	1

	A	a
B	⬛	⬛
b	⬛	⬛

All = 1

	A	a
B	1/4	1/4
b	1/4	1/4

	A	a
B		
b		

	A	a
B	🟥	
b	🟥	

A = 2/3

	A	a
B	1/3	1/6
b	1/3	1/6

	A	a
B	λ_A	
b	λ_A	

	A	a
B	🟫	
b	🟫	

A = 2/3

	A	a
B	1/3	1/6
b	1/3	1/6

	A	a
B	$\lambda'_A+\lambda''_A$	
b	$\lambda'_A+\lambda''_A$	

Example: Named Entity Feature Overlap

Grace is correlated with PERSON, but does not add much evidence on top of already knowing prefix features.

Local Context

	Prev	Cur	Next
State	Other	???	???
Word	at	Grace	Road
Tag	IN	NNP	NNP
Sig	x	Xx	Xx

Feature Weights

Feature Type	Feature	PERS	LOC
Previous word	*at*	-0.73	0.94
Current word	*Grace*	0.03	0.00
Beginning bigram	*<G*	0.45	-0.04
Current POS tag	NNP	0.47	0.45
Prev and cur tags	IN NNP	-0.10	0.14
Previous state	Other	-0.70	-0.92
Current signature	Xx	0.80	0.46
Prev state, cur sig	O-Xx	0.68	0.37
Prev-cur-next sig	x-Xx-Xx	-0.69	0.37
P. state - p-cur sig	O-x-Xx	-0.20	0.82
…			
Total:		**-0.58**	**2.68**

Feature Interaction

- Maxent models handle overlapping features well, but do not automatically model feature interactions.

Empirical

	A	a
B	1	1
b	1	0

	A	a
B	⬛	⬛
b	⬛	⬛

All = 1

	A	a
B	1/4	1/4
b	1/4	1/4

	A	a
B	0	0
b	0	0

	A	a
B	🟥	
b	🟥	

A = 2/3

	A	a
B	1/3	1/6
b	1/3	1/6

	A	a
B	λ_A	
b	λ_A	

	A	a
B	🟫	🟫
b		

B = 2/3

	A	a
B	4/9	2/9
b	2/9	1/9

	A	a
B	$\lambda_A+\lambda_B$	λ_B
b	λ_A	

Feature Interaction

- If you want interaction terms, you have to add them:

Empirical

	A	a
B	1	1
b	1	0

	A	a
B	🟥	
b	🟥	

A = 2/3

	A	a
B	1/3	1/6
b	1/3	1/6

	A	a
B	🟫	🟫
b		

B = 2/3

	A	a
B	4/9	2/9
b	2/9	1/9

	A	a
B	🟩	
b		

AB = 1/3

	A	a
B	1/3	1/3
b	1/3	0

- A disjunctive feature would also have done it (alone):

	A	a
B	🟦	🟦
b	🟦	

	A	a
B	1/3	1/3
b	1/3	0

Quiz Question

- Suppose we have a 1 feature maxent model built over observed data as shown.
- What is the constructed model's probability distribution over the four possible outcomes?

Empirical

	A	a
B	2	1
b	2	1

Features

	A	a
B		
b	🟥	🟥

Expectations

Probabilities

	A	a
B		
b		

Feature Interaction

- For loglinear/logistic regression models in statistics, it is standard to do a greedy stepwise search over the space of all possible interaction terms.
- This combinatorial space is exponential in size, but that’s okay as most statistics models only have 4–8 features.
- In NLP, our models commonly use hundreds of thousands of features, so that’ s not okay.
- Commonly, interaction terms are added by hand based on linguistic intuitions.

Example: NER Interaction

Previous-state and current-signature have interactions, e.g. P=PERS-C=Xx indicates C=PERS much more strongly than C=Xx and P=PERS independently.

This feature type allows the model to capture this interaction.

Local Context

	Prev	Cur	Next
State	Other	???	???
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Tag	IN	NNP	NNP
Sig	x	Xx	Xx

Feature Weights

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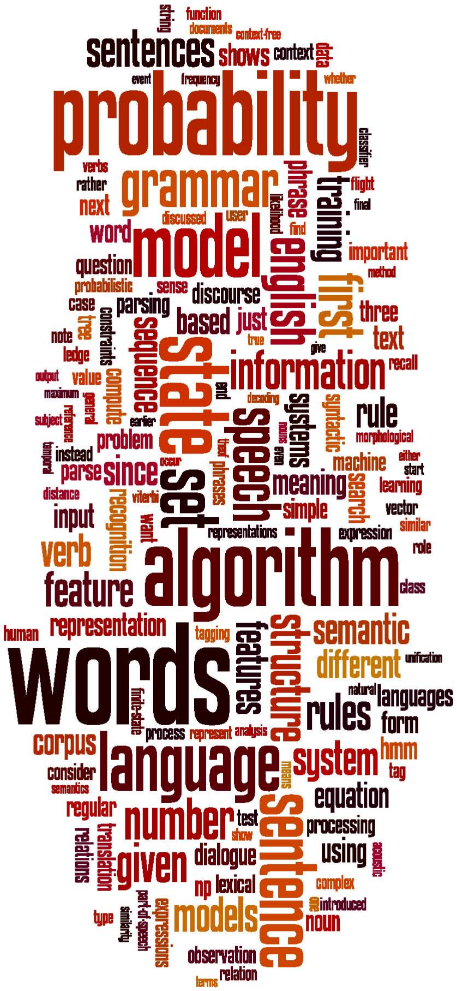

Feature Overlap/
Feature Interaction

How overlapping features
work in maxent models