



Cross-Situational Word Learning Under Uncertainty

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Cross-situational Word Learning

People are sensitive to the regularities across situations. [Yu & Smith, 2007]



A dax!



Look at the dax!

But, there is a lot of uncertainty in a child's environment:

- Referential uncertainty (e.g., the book)
- Linguistic uncertainty (e.g., "look")
- Low frequency words

Competitive-based biases help children reduce this uncertainty.



Mutual Exclusivity

[Markman & Wachtel, 1988]

Word Learning: Computational Level

Input: utterance: {look, at, the, goats}
scene: {LOOK, AT, THE, GOATS}

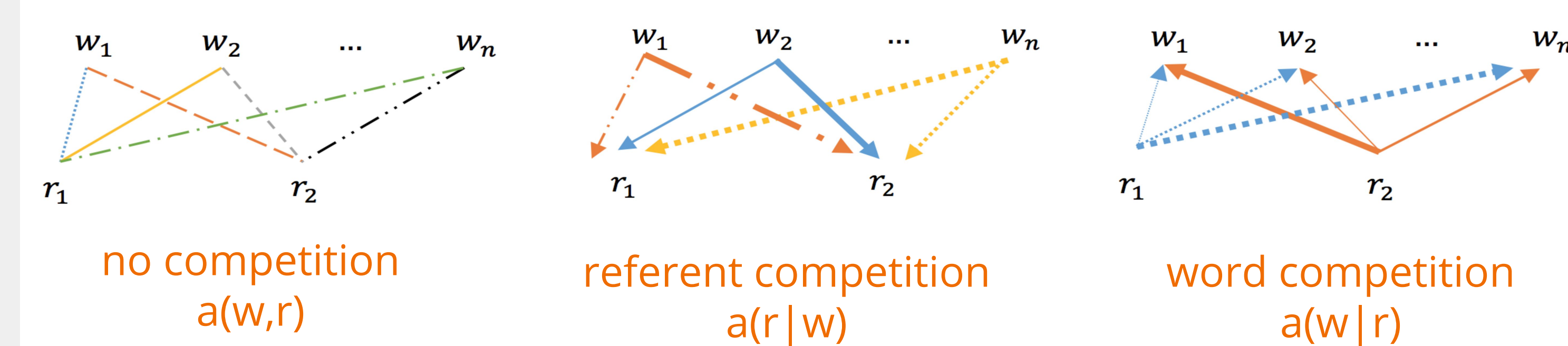
Problem: Learn a meaning representation for each word.

Solution: estimate a distribution over words and referents, Θ .

- Define a hidden variable, alignment, that specifies the mapping between words and referents in a given input pair.
- Initialize Θ with a uniform distribution.
- Calculate the probability of alignment variables.
- Find Θ that maximizes the expectation of the data given the alignment probabilities.

Word Learning: Algorithmic Level

In-the-moment learning: How is the alignment variable defined?



Overall learning: What distribution relates words and referents?

- $p(w,r)$ -- no competition
- $p(r|w)$ -- competition over referents

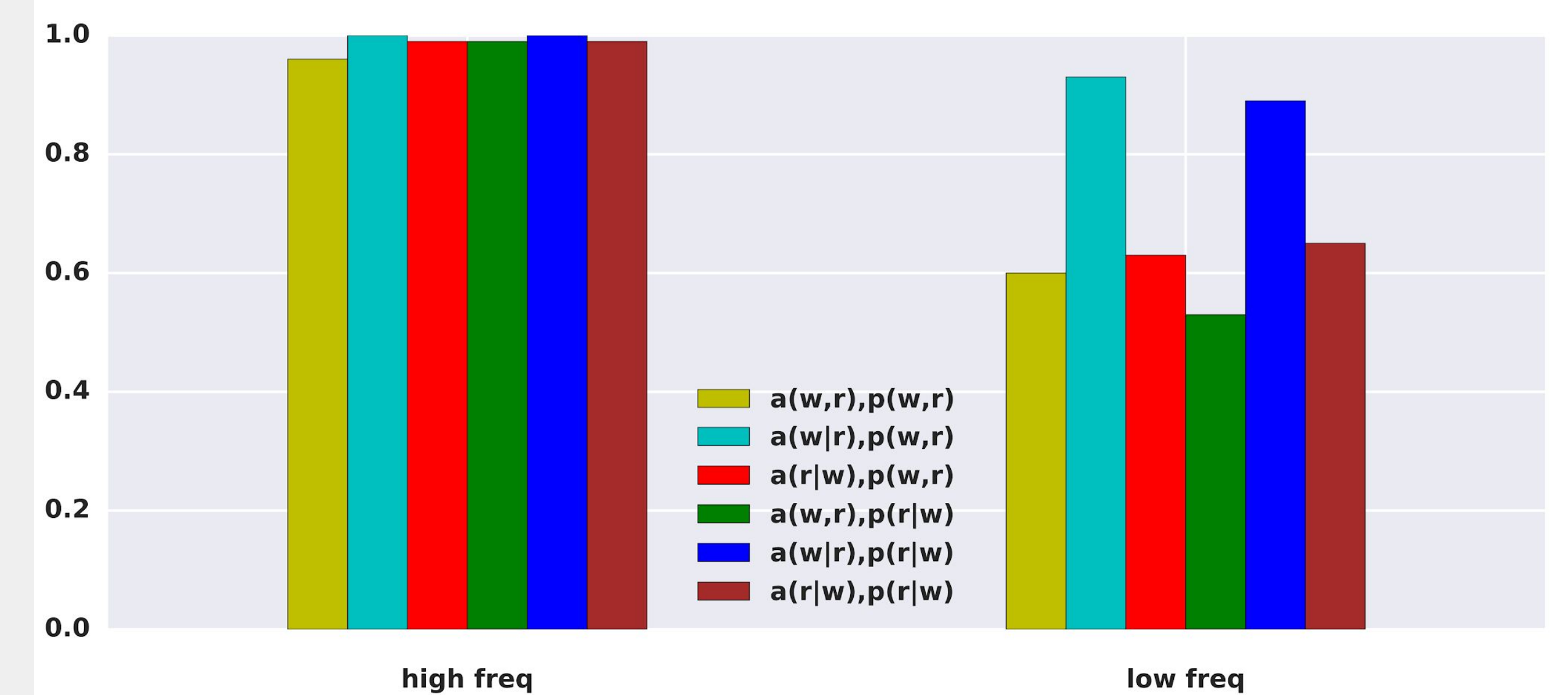
Inference: How are the learned word meanings used?

- cosine similarity -- competition over referents.

The Role of Frequency

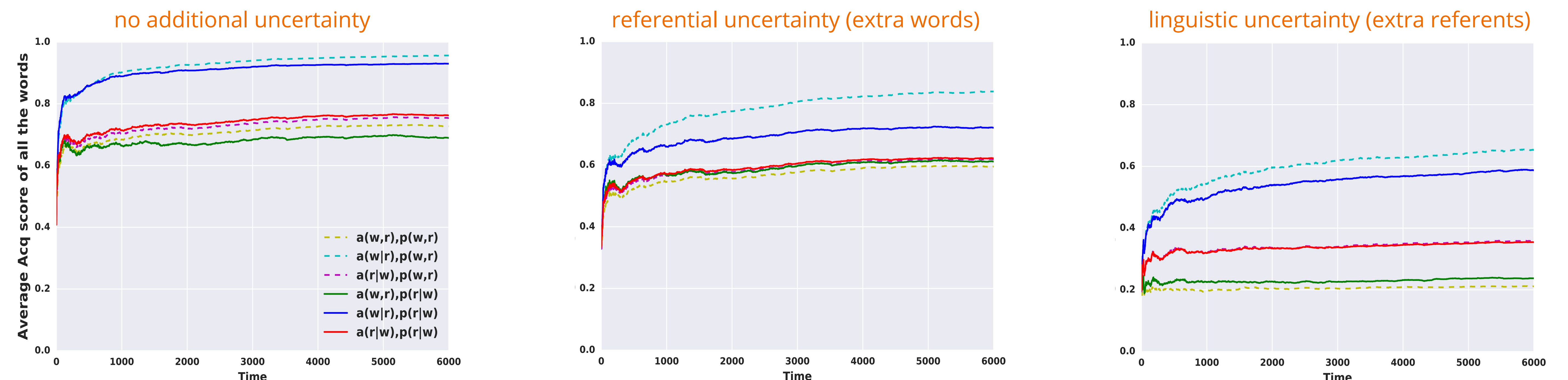
Examine the role of competitive processes for:

- low-frequency words (freq < 5)
- high-frequency words (freq > 10)



Competitive processes are especially important for learning low frequency word.

Overall Learning Patterns



The model with two types of competition (during in-the-moment learning and inference) is the most robust one in the presence of uncertainty.