

## What is Categorization?

**Categorization** is the process by which people group stimuli into categories and use those categories to reason about new stimuli they encounter.

Categories are generally represented according to either the **exemplar** or **prototype** approach.

Stimuli are generally represented using **feature norms**.

If we represent stimuli using **corpus features**, can we get similar performance on categorization tasks?

Does it matter whether we represent categories using **exemplars** or **prototypes**?

How can we compare different category and stimuli representations?

## Category Representation

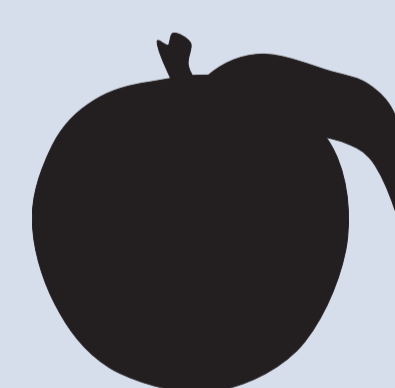
Multiple theories exist as to how people represent categories:

### Classical

- ▶ *is\_edible*
- ▶ *contains\_seeds*
- ▶ *grows\_above\_ground*
- ▶ *part\_of\_a\_plant*

A list of required features which all instances of FRUIT must possess

### Prototype



A single prototypical FRUIT from which all instances are generated

### Exemplar



A number of stored instances of FRUIT to which new instances are likely to be similar

## Meaning Representations

(a) Feature Norms

	<i>has_4_legs</i>	<i>used_for_eating</i>	<i>is_a_pet</i>
TABLE	12	9	0
DOG	14	0	15

(b) LSA

	Document 1	Document 2	Document 3
TABLE	0.02	0.98	-0.12
DOG	0.73	-0.02	0.01

(c) DV

	<i>subj-of-walk</i>	<i>subj-of-eat</i>	<i>obj-of-clean</i>
TABLE	0	3	28
DOG	36	48	19

(d) LDA

	Topic 1	Topic 2	Topic 3
TABLE	0.02	0.73	0.04
DOG	0.32	0.01	0.02

Semantic representations for TABLE and DOG using feature norms, Latent Semantic Analysis (LSA), Dependency Vectors (DV), and Latent Dirichlet Allocation (LDA).

## Data

- ▶ Exemplars and feature norms were taken from McRae et. al (2005).
  - ▷ 541 exemplars in 41 categories
- ▶ Category labels and typicality ratings were collected via Amazon Mechanical Turk.
  - ▷ Mean reliability: 0.64, SD: 0.03

## Models

$$sim_{w,c} = \sum_{x \in c} sim_{w,x}$$

(a) Exemplar

$$sim_{w,c} = sim_{w,c_{proto}}$$

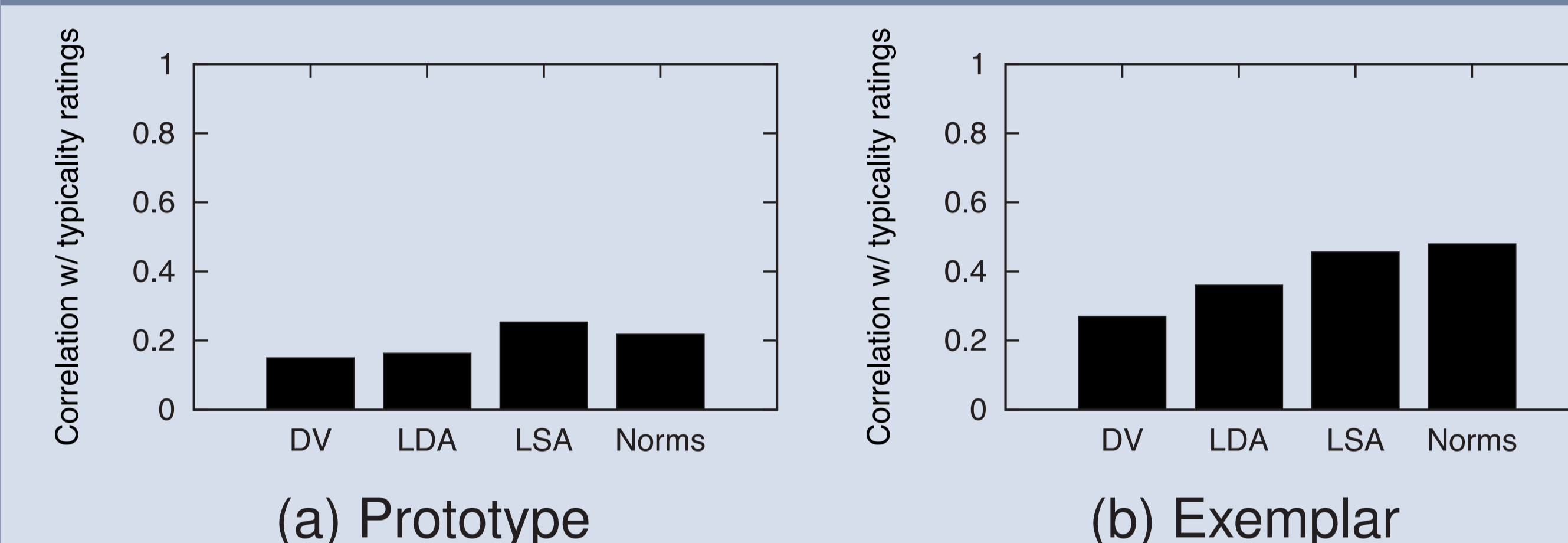
(b) Prototype

In both models  $sim_{w,x}$  is the cosine distance between stimuli.

## Experiment

- ▶ Train four exemplar models (Nosofsky 1992) and four prototype models (Vanpaemel 2005), one per representation.
- ▶ For each model typicality  $\approx sim_{x,c}$ .
- ▶ Compare average correlation between model- and human-predicted typicality ratings.

## Results on Typicality



Average correlation for prototype (a) and exemplar (b) models between model- and human-predicted typicality rating, using various meaning representations.

## Discussion

- ▶ Document co-occurrence (LSA) yields comparable performance vs. feature norms.
- ▶ Exemplar models overwhelmingly beat out prototype models.
- ▶ Low correlations even when using feature norms suggest that even humans have trouble with the task.
- ▶ **Future work:** can we achieve greater performance by using specialized models for natural language categorization that are tailored to corpus-based meaning representations?

## Bibliography

- McRae, K., Cree, G. S., Seidenberg, M. S., and McNorgan, C. (2005). Semantic feature production norms for a large set of living and non-living things.
- Nosofsky, R. M. (1992). Exemplars, prototypes, and similarity rules.
- Vanpaemel, W., Storms, G., and Ons, B. (2005). A varying abstraction model for categorization.