Learning Language in Wubble World

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Welcome

Wubble World is a fun place to meet new friends and play creative games. Wubbles are curious and intelligent creatures, as you'll find out when you teach your very own Wubble about the world it lives in. You and your Wubble can compete with other players and win cool accessories.

Enter now to customize your Wubble and begin playing!
Learning Language in Wubble World

- Wubble World engages children in the task of teaching their wubbles English
- Unlike most statistical NL, Wubble World provides the language learner with a scene, focal tasks, and a competent teacher
How Wubbles Learn the Meanings of Words

"Go to the blue cylinder"

1. parse

2. retrieve a semantic representation of a word or phrase

3. score correspondences between retrieved representation and scene

4. act or ask

5. given positive feedback, update semantic representation
Representing Word Meanings

When a wubble encounters a new word, it uses the parse tree to guess at a part of speech and builds an appropriate feature vector for the word.

Nouns have five features: type, color, size-x, size-y, size-z.

A vector of uniform distributions over each feature is created:

With experience, this vector becomes specialized to each word.
Prepositions

Standard landmark-trajector model
Space is divided into X,Y,Z dimensions
Relative to trajector, five values:
  negative far, negative near, zero, near, far

E.g., "behind" means
  X=zero, Y=zero, Z=negative near
Scoring Correspondences between Imagined and Scene Objects

\[ F_i = \{f_0, \ldots, f_k\} \]
\[ F_{\text{shape}} = \{\text{cylinder, cone, cube, wedge, sphere}\} \]

\[ H'(F_i) = - \sum_{f \in F_i} \frac{\Pr(f) \log \Pr(f)}{\log K} \]

\[ H'(F_{\text{shape}}) = - \sum_{f \in F_{\text{shape}}} \frac{\Pr(f) \log \Pr(f)}{\log 5} \]

\[ I = \text{an imagined object} \]
\[ \text{S} = \text{an object in the scene} \]
\[ f_i(O) = \text{value of the } i\text{th feature of } O \]
\[ \text{match}(f_i) = 0 \text{ if } f_i(I) = f_i(O) \text{ else } 1 \]
\[ \Delta(I,O) = \sum_{F_j} \text{match}(f_i) \times (1 - H'(F_j)) \]

| \( F_1(O) \) | bad |
| \( F_1(I) \) | |
| \( F_2(O) \) | not great |
| \( F_2(I) \) | |
| \( F_3(O) \) | good |
| \( F_3(I) \) | |
Updating Word Meanings

When the wubble has found the scene object that best corresponds to its imagined object, it **acts or asks**

Positive feedback means

- It acts and isn't told "no" (e.g., moves to an object)
- It asks and the answer is "yes" (e.g., "is this the blue cylinder?")

In these cases it updates its feature vectors associated with a word or phrase to make them more like those of the scene object:

Before feedback

![Before feedback graph](image1)

After feedback

![After feedback graph](image2)
Experiments

Training: Utter sentence and point to object, e.g., "Choose the small red cube," and "Choose the red one."

Noun/adjective tests: Tell the wubble to choose an object, count how many guesses it took to find the right object.

Adjective tests: Wubble had to identify a region of space

At least one object/region of space in the room matched the test sentence. Wubble credited with any match.

Referential ambiguity manipulated by having more or fewer objects in the room

In transfer condition, Wubble knew the meanings of color terms
Ongoing Work: Two ways to teach Wubbles English

Human types directly to wubble, who asks/acts and gets feedback
Online learning
Sharing knowledge among wubbles

Chat-room cooperative game played by humans' wubble avatars
Record speech and scenes
Offline process speech to text
Build Sentence-Scene Corpus
Process with parallel-corpus tree-adjoining grammar induction