Situated Language Learning

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Why is it hard for a machine to learn language?

- Insufficient amount of ‘right kind of data’.
- Limitations of the statistical methods.

What is Situated Language Learning?

- Situated Language Learning is an improvement in the statistical methods, we traditionally use for making machine learn the language.
- It also takes into consideration the physical context in which the word/sentence is used.

Importance of Being Social

- Social interaction plays an instrumental role in the acquisition of language by providing many tools.
- One such tool is shared attention: When parents ask a child to get a toy, they see towards it or point to it.
- Similarly in our game the human will tell the computer by pointing towards the right object.

Wubble World to Entropy Learning

- Our work is largely motivated by the work of Wubble World by Kerr et al.
- Problem with ww2d and ww3d
  - ww2d required a great amount of data mining for verb learning.
  - ww2d was not so interactive.
  - ww3d had its own compiling complexities
  - No documentation for ww3d was available.

Entropy Learning: Introduction

- Our entropy learning system has 27 different kind of objects.
- People train the virtual character to learn to associate various nouns/adjectives to different objects by pointing towards the right object.
- Slowly virtual character learns various relevant nouns and adjectives.

Entropy Learning: An Overview

Welcome to the virtual world.
There are 2 modes in this world :

- Teach Mode : In the teach mode, the virtual character tries to learn basic nouns and adjectives. 6 random objects are shown in an image window. You must make the virtual character learn what nouns/adjectives are used to describe the various objects in the scene.
  This can be done by passing simple instructions to the virtual character.
  eg. Which is the blue disc?
  The virtual character interacts by either asking for help, or by making a guess.

- Quiz Mode : In the quiz mode, the virtual character is shown a random object, and the virtual character must list the nouns/adjectives related to the shown object.

Concept Acquisition

- In this virtual world, virtual character 'sees' every object as a 3 dimensional vector corresponding to its 3 attributes :
  - Shape – (circle,square,triangle)
  - Size – (small,medium,large)
  - Color – (red, green, blue)

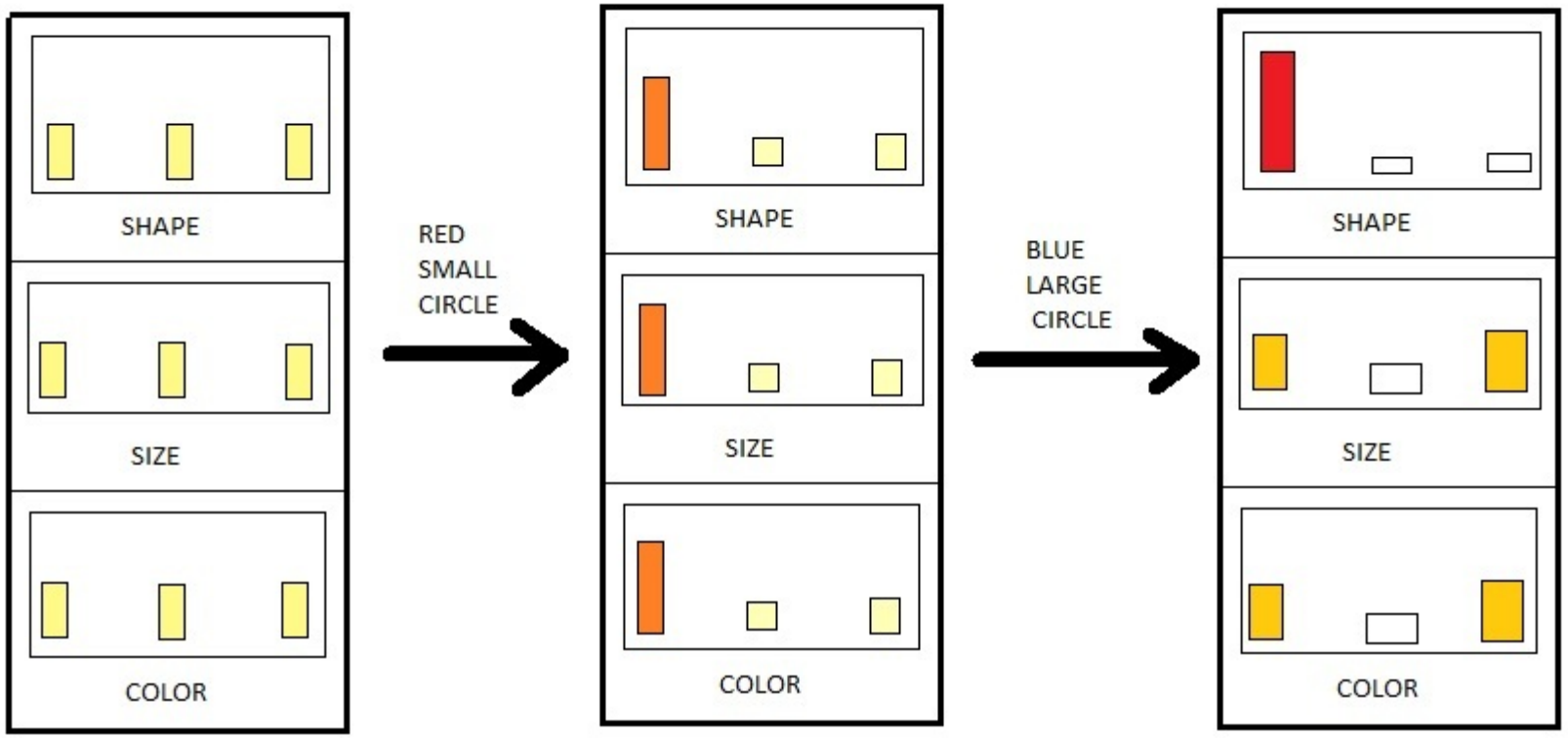
- Initially all attributes will have uniform distribution.

- As the virtual character learns about a language component, certain values start to rise more than others and on this basis virtual character start to associate those properties with that word.

- A feature for correction/feedback is also incorporated.

Concept Acquisition

- Multiplicative update for features, based on Freund and Schapire[2]



CONCEPT ACQUISITION FOR CIRCLE

Concept Resolution

- Concept resolution happens in 2 stages:

1. Concept Resolution through Defining features :
   - We look at the feature which precisely defines the concept
   - Eg. Disc is defined by shape – circle; size and color don't matter
   - Leaf is defined by color and shape; size doesn't matter

2. Concept Resolution through entropy measure :
   - This is executed when concept resolution through defining features fails
   - The virtual character looks for the object which is closest to the 'prototype' that it has imagined.
   - How do we define 'closeness' of concepts?

Concept Resolution

The intuition behind 'closeness' of concepts :

- Trust the features that have less entropy (concentrated distribution)

Kerr et al[1] define the scaled entropy of a feature as follows :

$$H'(P) = \frac{-\sum p_i \log(p_i)}{\log 3}$$

The distance from object A to object B is defined as follows :

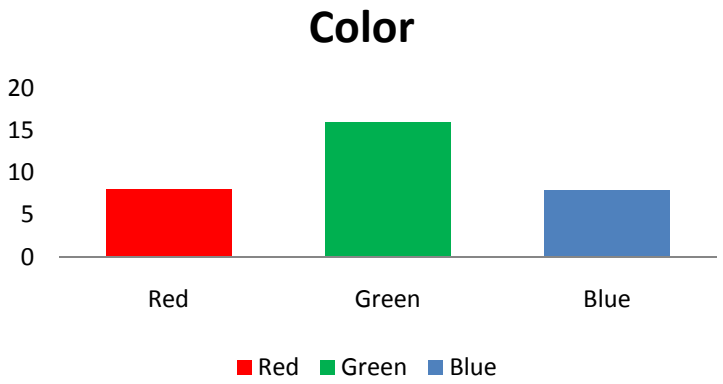
$x_i = 1$ if $a_i = b_i$, 0 otherwise

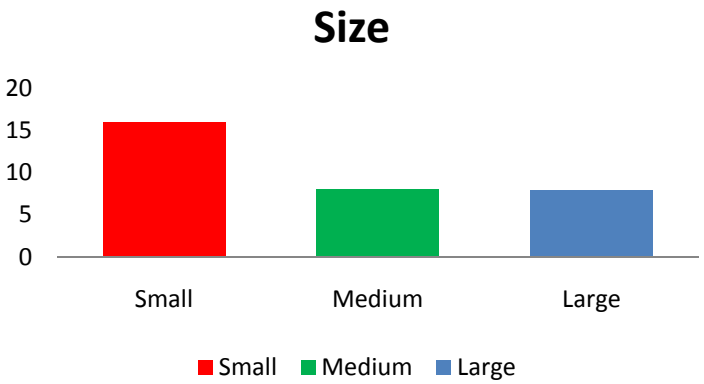
$$d = \sum x_i(1 - H'(P_i))$$

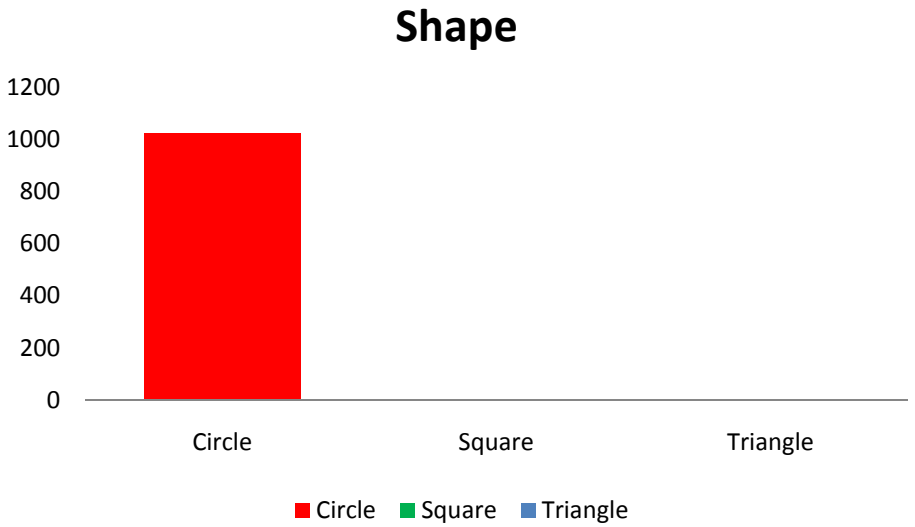
Hence, if some concept is characterized by a particular feature, H'(P) will be high, and thus we would want the corresponding x_i to be 0.

Results

Disc

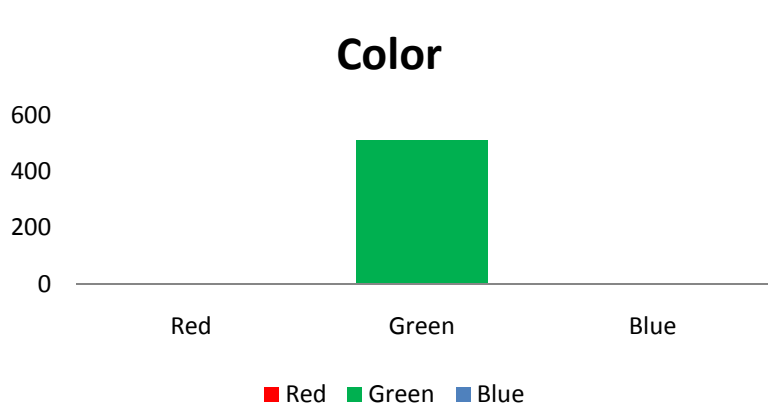


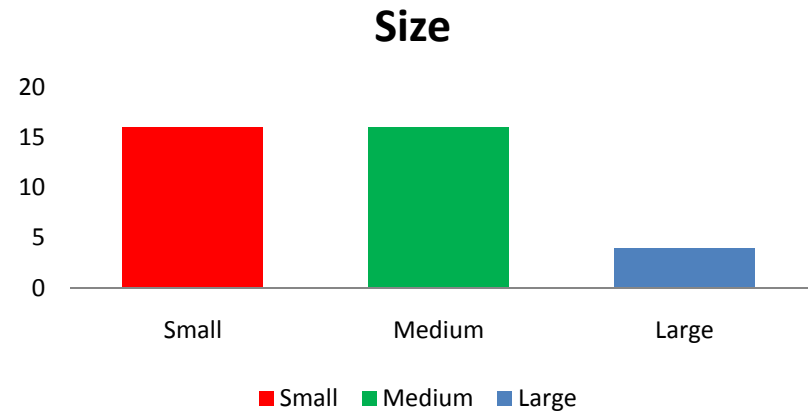


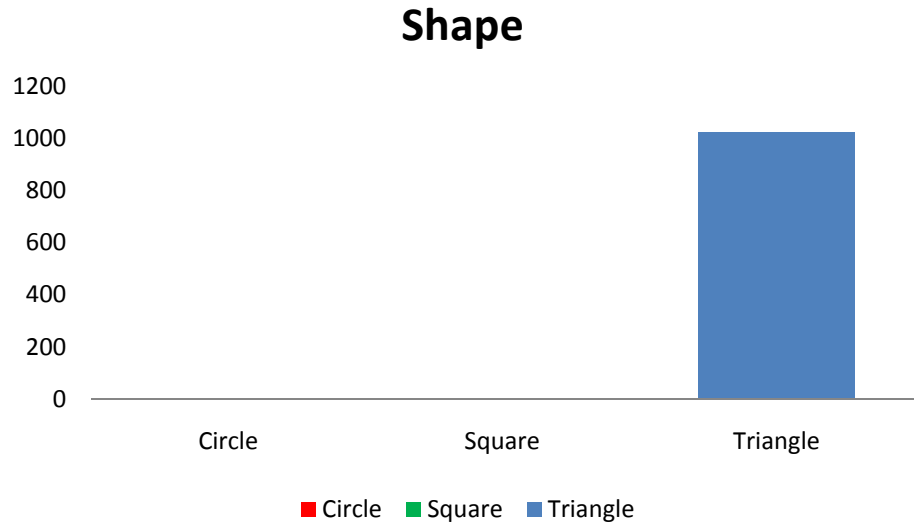


Results

Leaf







Future Scope

- More modes can be introduced.
- More features can be added to quiz mode.
- Can be made more interesting by working on graphics.
- This can be extended so that we can study learning of prepositions and verbs as well.

References

1. Wesley Kerr. Shane Hoversten. Daniel Hewlett. Paul R. Cohen. Yu-Han Chang. 2007. *Learning in Wubble World .* IEEE International Conference on Development and Learning.

2. Auer, P.; Cesa-Bianchi, N.; Freund, Y.; and Schapire, R. 1995. Gambling in a rigged casino: The adversarial multi-armed bandit problem. In Proceedings of the 36th Annual Symposium on Foundations of Computer Science, 322–331.

3. Daniel Hewlett. Shane Hoversten. Wesley Kerr. Paul R. Cohen. Yu-Han Chang. 2007. *Wubble World.* Artificial Intelligence and Interactive Digital Entertainment.