Probabilistic Refinement Algorithms for the Generation of Referring Expressions

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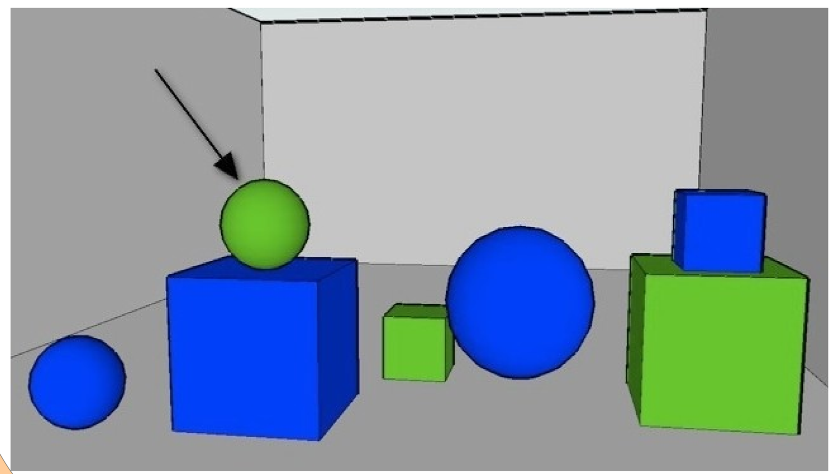
INTRODUCTION

We propose a **refinement** algorithm that generates referring expressions that are:

- Relational: *ball on the blue cube*
- Overspecified: *small green ball on the blue cube*
- Non-deterministic: *green ball, small ball on the right*



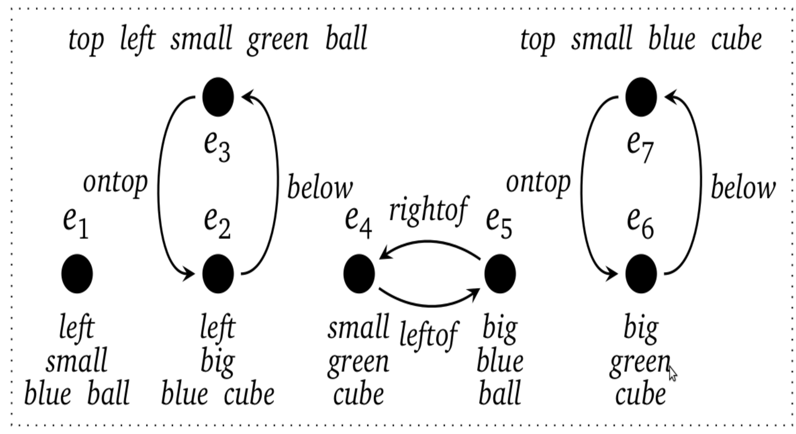


Figure 2: Scene as a relational model

LEARNING PROBABILITIES OF USE

- If there is corpus available:

$$R.p_{use} = \frac{\#\text{ of REs in } C \text{ in which R appears}}{\#\text{ of REs in } C}$$

- Feature used to learn $R.p_{use}$ when there is not corpus available

R.target-has	true if the target is in R
R.landmark-has	true if a landmark is in R
R.discrimination	1 / # objects in the model that have R
#bin-relations	number of binary relations of the target
#relations	number of relations of the target

REFINEMENT ALGORITHMS NON-DETERMINISM AND OVER-SPECIFICATION

Algorithm 1: Computing $\mathcal{L}$-similarity classes

RE $\leftarrow \{\top\}$
repeat
  while $\exists(\varphi \in \text{RE}).(\#\|\varphi\| > 1)$ **do**
    RE' $\leftarrow$ RE
    for (R, $R.p_{use}$) $\in$ Rs **do**
      if $R.rnd_{use} \leq R.p_{use}$ **then**
        for $\varphi \in$ RE **do** add$_{\mathcal{E}\mathcal{L}}$(R, φ, RE)
      if RE $\neq$ RE' **then**
        exit
    if RE = RE' **then**
      exit
  for (R,$R.p_{use}$) $\in$ Rs **do** $R.p_{use} \leftarrow R.p_{use} + R.inc_{use}$
until $\forall((R,R.p_{use}) \in \text{Rs}).(R.p_{use} \geq 1)$

Probabilistic Non-deterministic step

Completeness step

Algorithm 2: add$_{\mathcal{E}\mathcal{L}}$(R, φ, RE)

if FirstLoop? **then**
  Informative $\leftarrow$ TRUE
else Informative $\leftarrow \|\psi \sqcap \exists R.\varphi\| \neq \|\psi\|$;
for $\psi \in$ RE with $\#\|\psi\| > 1$ **do**
  if $\psi \sqcap \exists R.\varphi$ is not subsumed in RE **and**
   $\|\psi \sqcap \exists R.\varphi\| \neq \emptyset$ **and**
   Informative **then**
    add $\psi \sqcap \exists R.\varphi$ to RE
    remove subsumed formulas from RE

Overspecification Step/ (Egocentric)

Refinement Step/(Adjustment)

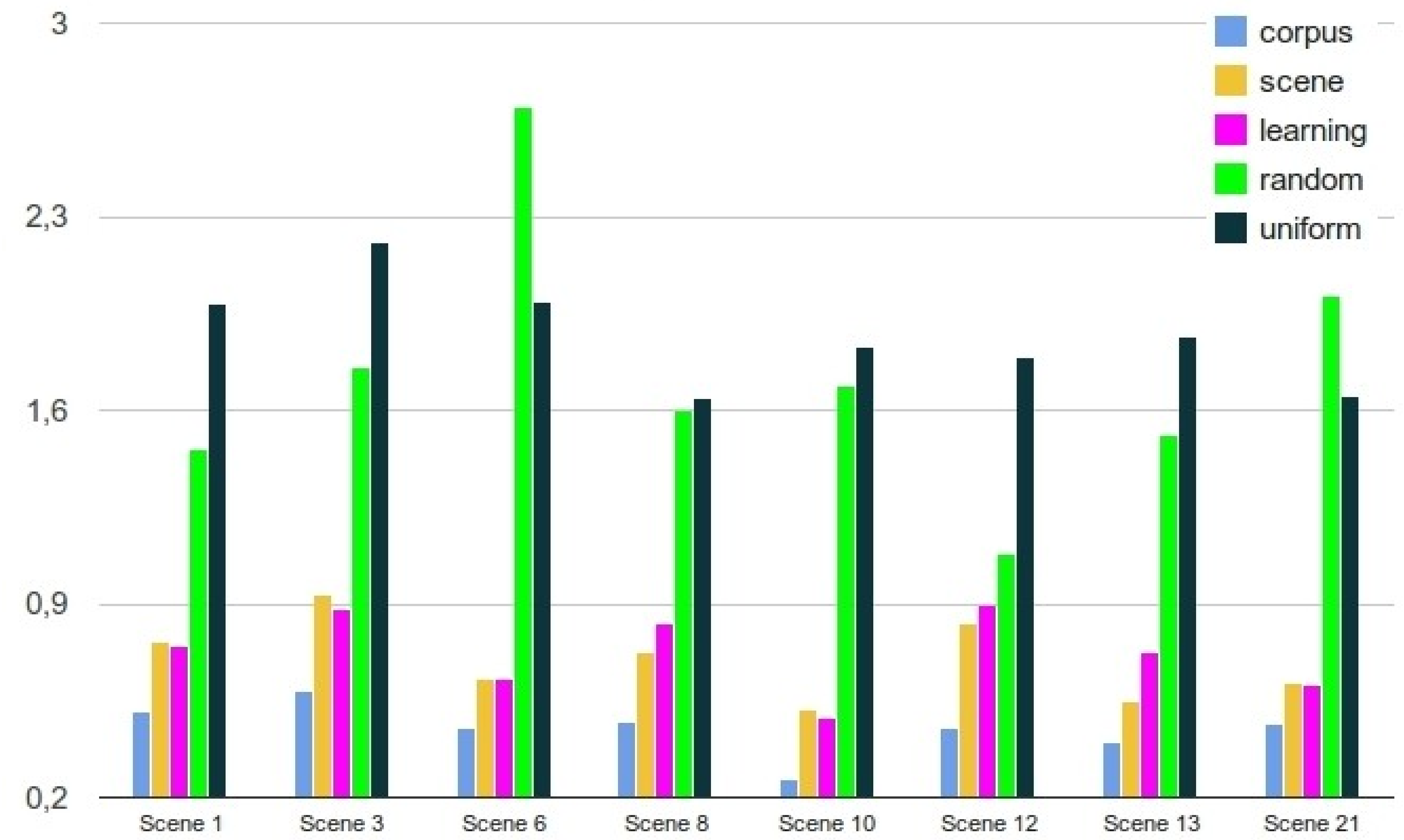
EVALUATION WITH PRECISION

Accuracy between the REs in the corpus and those generated using puse values computed from the scene, machine learned, random and uniform.

	Scene p_{use}	Learned p_{use}	Random p_{use}	Uniform p_{use}
Scene 1	85.75%	84.49%	17.95%	5.37%
Scene 3	82.81%	80.51%	9.89%	4.40%
Scene 6	90.11%	83.30%	4.13%	4.16%
Scene 8	86.52%	64.06%	16.32%	9.75%
Scene 10	89.49%	75.80%	7.56%	3.70%
Scene 12	80.21%	81.29%	57.09%	6.68%
Scene 13	89.98%	50.79%	9.30%	3.59%
Scene 21	92.13%	80.01%	8.45%	6.77%
Average	87.13%	75.03%	16.34%	5.55%

EVALUATION WITH CROSS ENTROPY

Cross-entropy between the corpus distribution and different runs of the algorithm.



- Our algorithm is able to generate different referring expressions for the same target with a frequency similar to that observed in corpora.
- Our results support the psycholinguistic theory that puts forward an egocentric explanation of language production (Keysar, 1998).