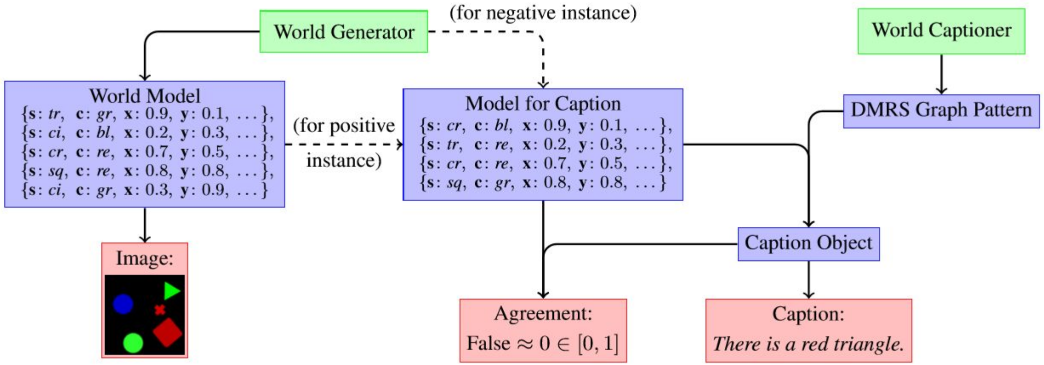
ShapeWorld - A new test methodology / environment

- Generate abstract microworlds of colored shapes
- Evaluate multimodal deep learning models
- Focus on “formal-semantics-style” tasks
- Test for multimodal language understanding and generalization abilities
- Analyze the learning process and basic capabilities of deep networks



World Generator

(for negative instance)

World Model

$\{\mathbf{s}: tr,\ \mathbf{c}: gr,\ \mathbf{x}: 0.9,\ \mathbf{y}: 0.1,\ \ldots\},$
$\{\mathbf{s}: ci,\ \mathbf{c}: bl,\ \mathbf{x}: 0.2,\ \mathbf{y}: 0.3,\ \ldots\},$
$\{\mathbf{s}: cr,\ \mathbf{c}: re,\ \mathbf{x}: 0.7,\ \mathbf{y}: 0.5,\ \ldots\},$
$\{\mathbf{s}: sq,\ \mathbf{c}: re,\ \mathbf{x}: 0.8,\ \mathbf{y}: 0.8,\ \ldots\},$
$\{\mathbf{s}: ci,\ \mathbf{c}: gr,\ \mathbf{x}: 0.3,\ \mathbf{y}: 0.9,\ \ldots\}$

(for positive instance)

Model for Caption

$\{\mathbf{s}: cr,\ \mathbf{c}: bl,\ \mathbf{x}: 0.9,\ \mathbf{y}: 0.1,\ \ldots\},$
$\{\mathbf{s}: tr,\ \mathbf{c}: re,\ \mathbf{x}: 0.2,\ \mathbf{y}: 0.3,\ \ldots\},$
$\{\mathbf{s}: cr,\ \mathbf{c}: re,\ \mathbf{x}: 0.7,\ \mathbf{y}: 0.5,\ \ldots\},$
$\{\mathbf{s}: sq,\ \mathbf{c}: gr,\ \mathbf{x}: 0.8,\ \mathbf{y}: 0.8,\ \ldots\}$

World Captioner

DMRS Graph Pattern

Caption Object

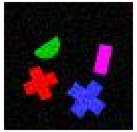
Image:

Agreement: False $\approx 0 \in [0, 1]$

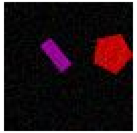
Caption: *There is a red triangle.*

OneShape

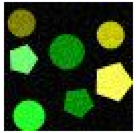
MultiShape



Spatial



Quantifier



CLIC Lab

‘All dogs have four legs’: Learning Natural Language Quantifiers from Visual Experience

Bernardi, R.[1], Herbelot, A.[1], Kuhnle, A.[2], Pezzelle, S.[1], Sorodoc, I.[1]

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Overview

What can we infer from such experience?

- ➔ All dogs have ***four legs***. / No dog has ***two legs***.
- ➔ Most dogs are ***brown***. / Some dogs are ***black***. / No dog is ***red***.
- ➔ All dogs have a ***tail***.
- ➔ etc

Motivation

- From **limited visual experience** of objects, humans learn to generalize to rough frequency estimates of object **attributes** for a certain **concept**.
- **Natural language quantifiers** (*no*, *some*, *most*, *all*, etc) are used to express these frequency estimates.
- Hence they act as a **proxy** revealing the **learned representation** of this cognitive process (to some degree, at least).

Aim of this project

- Create a dataset resembling this learning setup
- Evaluate various deep learning models on this task

Creating the dataset

Two approaches:

1. Using **quantified McRae's feature norms** (Herbelot and Vecchi, 2016):
   a. Extract images from **existing resources** (Visual Genome, MS COCO, etc) based on their provided annotations of objects and attributes.
   b. Query image **search engines** like Google, Bing, etc for *"<concept> <attribute>"*.
   c. **Control for agreement** between attribute frequency and associated quantifier.
2. Relying on **annotations of image datasets** (Visual Genome, MS COCO):
   a. Obtain **relative frequencies** of attributes for all concepts.
   b. **Map** these attribute frequencies to the **corresponding quantifier**, according to traditional formal semantic interpretation.

Ongoing issues

1. Problems with McRae’s feature norms:
    a. **Bad coverage** in existing resources (attributes do not match dataset annotations).
    b. Concepts are **too specific** and many attributes are **not visual**.
2. Problems with existing datasets:
    a. MS COCO: **only** 29 concepts, **only** few properties well-represented for each concept.
    b. Visual Genome: attributes **too sparse** / **too specific** (however, good concept coverage).
3. Images obtained from search engines:
    a. Results are **unreliable** and **inconsistent**, hence require **manual filtering**.
    b. **Vague concept boundaries** lead to many **“borderline” results**, which are hard to classify.
    c. Search results are sometimes **biased** towards some kind of **“prototypical” image structure**.

How we want to continue...

- Stick with McRae’s feature norms, since they are based on judgements of what humans consider “typical” for a concept.
- Focus on the Visual Genome dataset due to its good concept coverage.
- Include all attributes, even when covered only by a single image.

Dataset / Task

- Sample sequences of images (~100?, flexible) which consists of a certain attribute-per-concept frequency, amongst other attributes and concepts.
- Given such a sequence, target concept and attribute, the system has to decide which quantifier applies.