# **Relationships from Entity Stream**

## **Martin Andrews**

martin@RedDragon.ai

Sam Witteveen sam@RedDragon.ai

## Summary

Task :

▲ Q&A about relationships between objects in an image (Sort-of-CLEVR)

**Inspiration** :

A Relation Network paper

## **Model Comparison**



#### Idea :

- Focus attention on entities in image
- ▲ Stream relevant entities
- ▲ Learn relationships from stream

## **Results** :

Similar accuracy to previous work

## **Qualitative Advantages :**

- Only entities are reasoned about
- ▲ Greater interpretability
- **Fewer parameters**
- End-to-end trainable grounding

## **Source Code with Data Generator :**

Available via GitHub :

https://github.com/mdda/ relationships-from-entity-stream

## **Model Detail**

## **Input CNNs :**

▲ 4 layers, 3x3 conv 24 channels + BN

#### **Question & Answer :**

- Pre-encoded as 11d & 10d binary
- ▲ Q:[r, g, b, o, k, y, q1, q2, s1, s2, s3]
- ▲ A:[yes, no, rect, disc, 1, 2, 3, 4, 5, 6]

## **Entity Finder RNN :**

- ▲ 2-layer GRU, 32/64 hidden dims
- Output is query 'q' for attending
- Found 'entities' input to next timestep

## **Attention-is-all-you-need :**

Concatenate location to CNN output ▲ Split into 'k' and 'v' pieces

## Results

#### Quantitative

Model	NonRel fraction correct	BiRel fraction correct	hidden_dim	Size in bytes
RN	99%	93%	-	1,463,513
CNN	$98\%^*$	63%	-	970,874
Our RFES-S	99%	95%	32	166,380
Our RFES-H	[ 99%	93%	64	408,364

## Qualitative



## Discussion

### **Motivation :**

- Avoid comparing all locations pairwise
- Want sequential reasoning
- Potential to mix & match streams

## **SoftMax Attention :**

- Works quickly, more robust
- Capable of 'cheating' by snapshotting
  - entity scene (e.g. to count)

## Hard Attention :

- Some tuning required (larger GRU)
- ▲ Gumbel has self-scaling property
- Training still fully differentiable

- $\blacktriangle$  Soft attention : weighted 'v' as entity
- ▲ Gumbel trick to learn hard attention

## **Relationship Finder RNN :**

- $\blacktriangle$  Inputs are entities ('v' from attention)
- ▲ 2-layer GRU, 32/64 hidden dims
- Answer from last hidden state

#### Testing explicitly 'ArgMax hard'

### **Future directions :**

- Small-RL and attention games
- Revisit MNIST by saccades
- Other uses of 'internal dialogue'

# **Key References**

"A simple neural network module for relational reasoning" - Santoro et al. (2017)

"Attention is all you need" - Vaswani et al. (2017)

"The symbol grounding problem" - Harnad (1990)

