

# Multimodal KBs: Extraction & Completion

Sameer Singh

University of California, Irvine

## Gray Vinyl Barstool

This sleek dual purpose stool easily adjusts from counter to bar height. The backless design is casual and contemporary which allow it to seamlessly accent any area in the home. The easy to clean vinyl upholstery is perfect when being used on a regular basis. The height adjustable swivel seat adjusts from counter to bar height with the handle located below the seat....

Color Finish	Gray
Style	Casual and Contemporary
Adjustable Height	Yes
Frame Material	Metal



Carles\_Puyol

isAffiliatedTo Spain\_national\_under-18\_football\_team

isAffiliatedTo Spain\_national\_under-21\_football\_team

isAffiliatedTo Spain\_national\_under-23\_football\_team

isAffiliatedTo Catalonia\_national\_football\_team

Carles\_Puyol, isAffiliatedTo, ??

Spain\_national\_football\_team

Italy\_national\_football\_team

Carles\_Puyol

isAffiliatedTo Spain\_national\_under-18\_football\_team

isAffiliatedTo Spain\_national\_under-21\_football\_team

isAffiliatedTo Spain\_national\_under-23\_football\_team

isAffiliatedTo Catalonia\_national\_football\_team

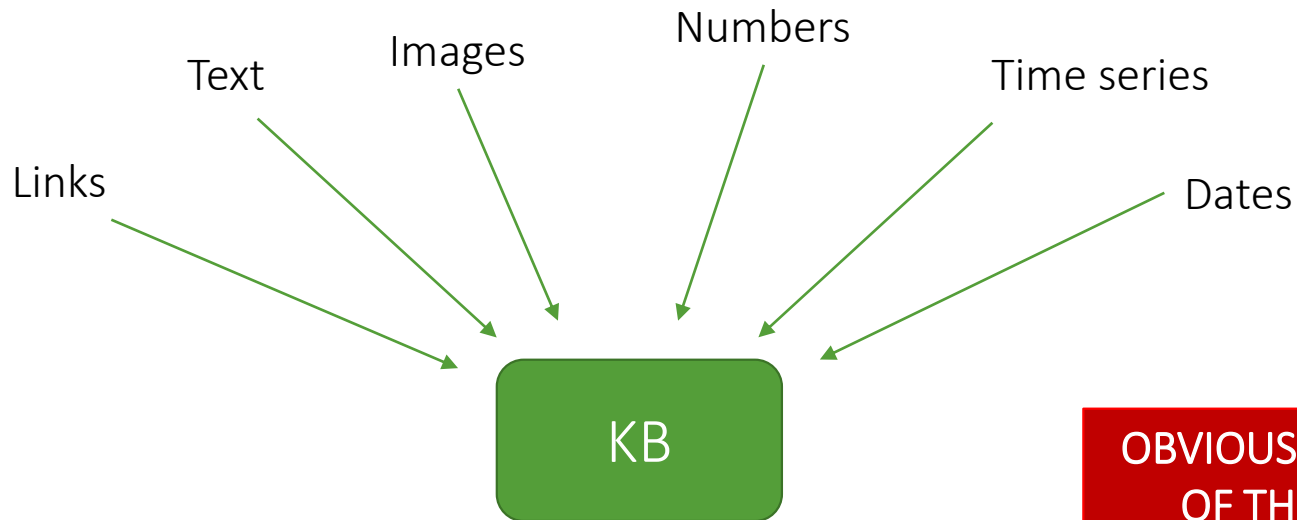
Carles\_Puyol, playsFor, ??

FC\_Barcelona



Real\_Madrid\_CF

# Information is in many modalities



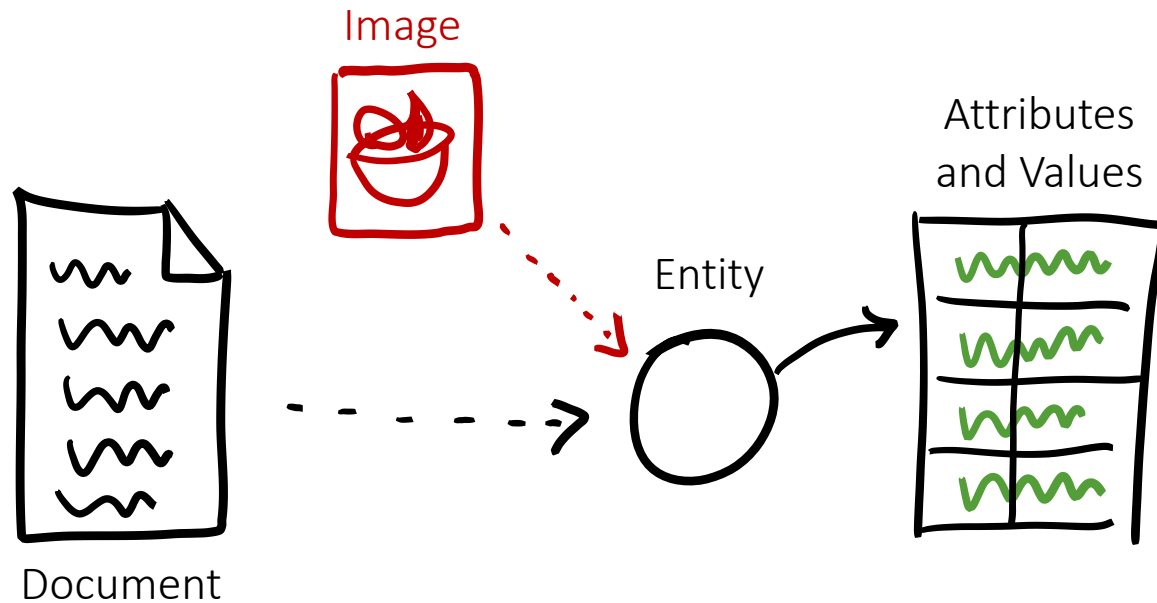
OBVIOUS STATEMENT  
OF THE YEAR!!!

Maybe we should be reasoning about all of these?

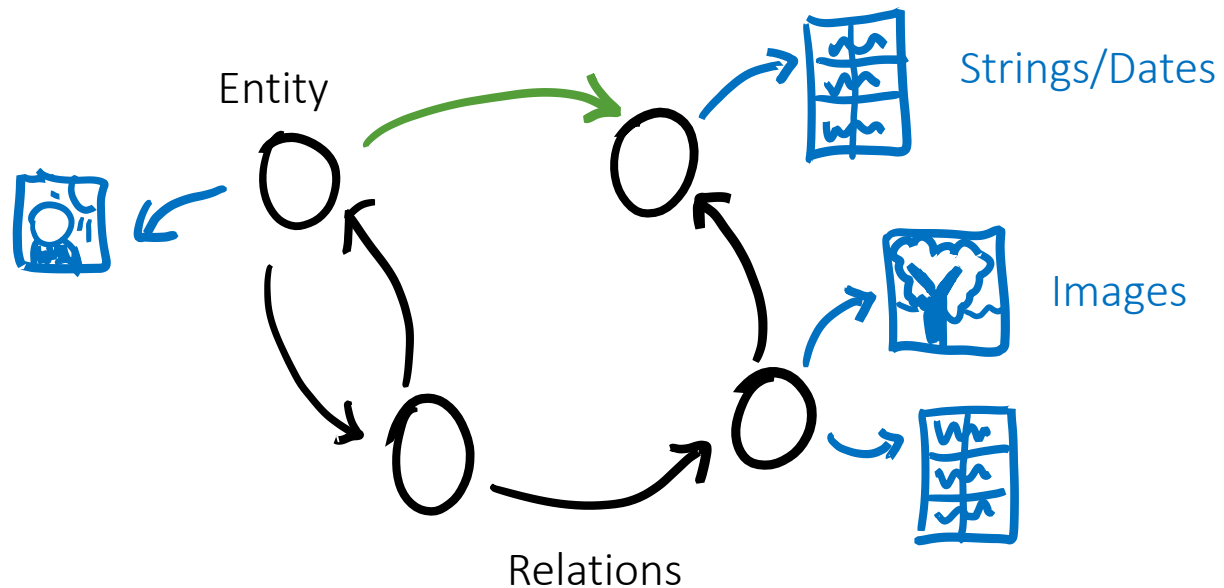
**Time is ripe for doing multimodal stuff**



# Task 1: Attribute Extraction

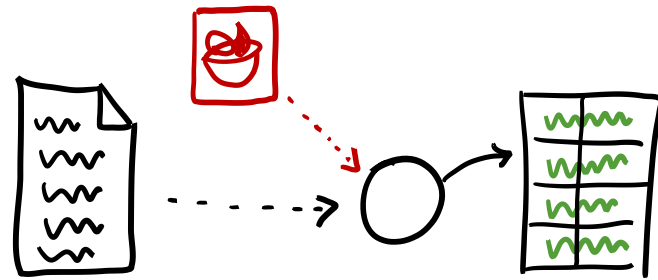


# Task 2: KB Completion

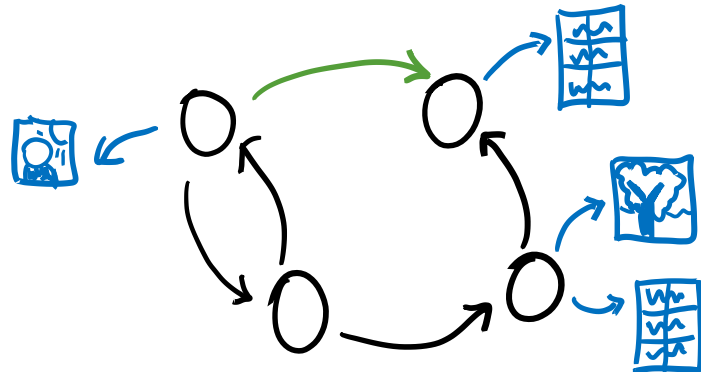


# Outline

Attribute Extraction



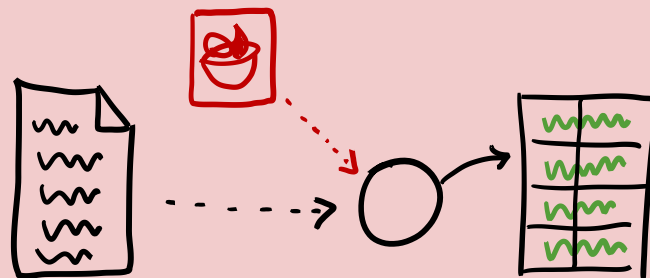
KB Completion





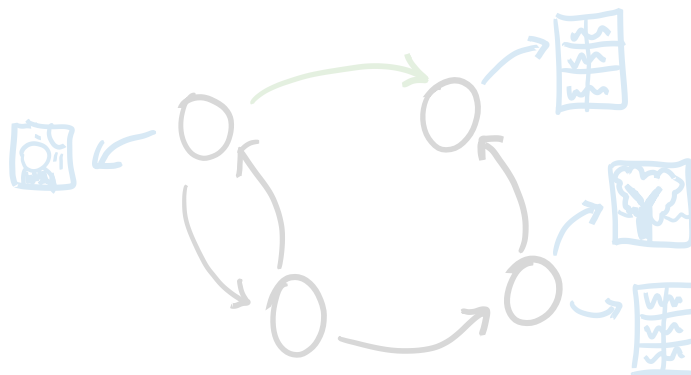
# Outline

## Attribute Extraction



work with **Robert Logan**, Samuel Humeau, Mike Tung

## KB Completion



# Attribute Extraction

## Gray Vinyl Barstool

This sleek dual purpose stool easily adjusts from counter to bar height. The backless design is casual and contemporary which allow it to seamlessly accent any area in the home. The easy to clean vinyl upholstery is perfect when being used on a regular basis. The height adjustable swivel seat adjusts from counter to bar height with the handle located below the seat....

$T_i$

$\{(a_{ij}, v_{ij})\}$

Color Finish Gray

Style Contemporary

Adjustable Height Yes

Frame Material Metal

# Multimodal Attribute Extraction

## Gray Vinyl Barstool

This sleek dual purpose stool easily adjusts from counter to bar height. The backless design is casual and contemporary which allow it to seamlessly accent any area in the home. The easy to clean vinyl upholstery is perfect when being used on a regular basis. The height adjustable swivel seat adjusts from counter to bar height with the handle located below the seat....

 $T_i$  $I_i$  $\{(a_{ij}, v_{ij})\}$ 

Color Finish Gray

Style Contemporary

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Frame Material Metal

# MAE Dataset

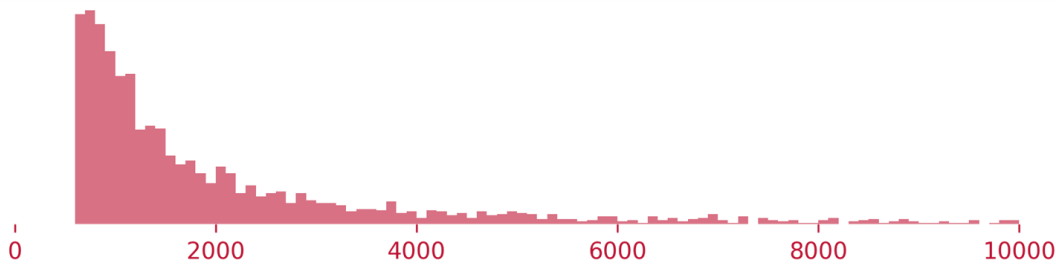
Cleaned up crawl of retail products in the Diffbot Knowledge Graph

Number of Entities	2.25 million
Number of Images	4.172 million
Number of unique Attributes	2,114
Number of unique Values	15,380
Number of Attribute-Value Pairs	7.671 million

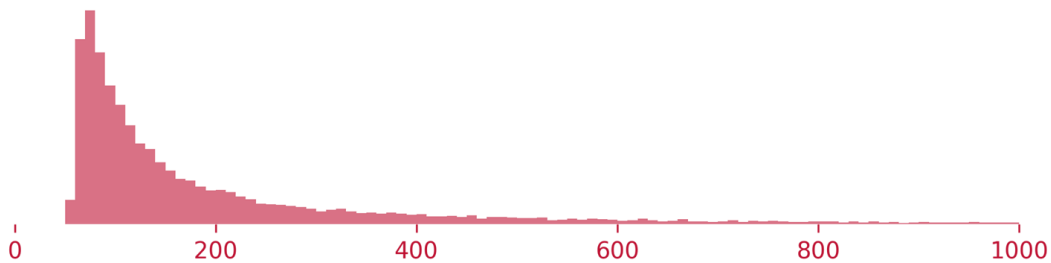


# Challenges: Noisy, Open Domain

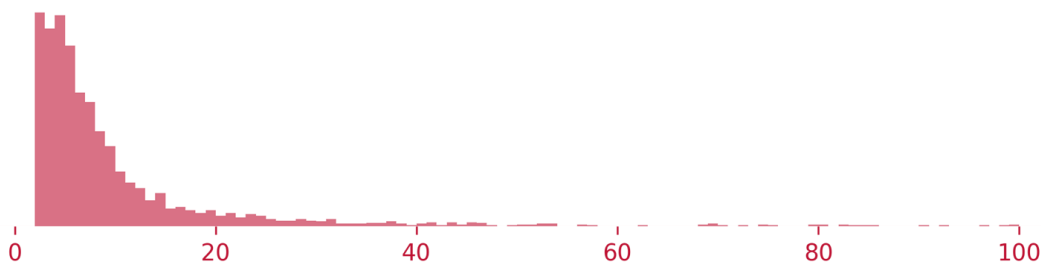
Histogram of Attribute Counts



Histogram of Value Counts



Histogram of Values per Attribute



Real-world, Open-domain

Different Categories of Items

Redundancy and Typos

Values for bluetooth\_ver:

- 4
- 4.0
- v4.0

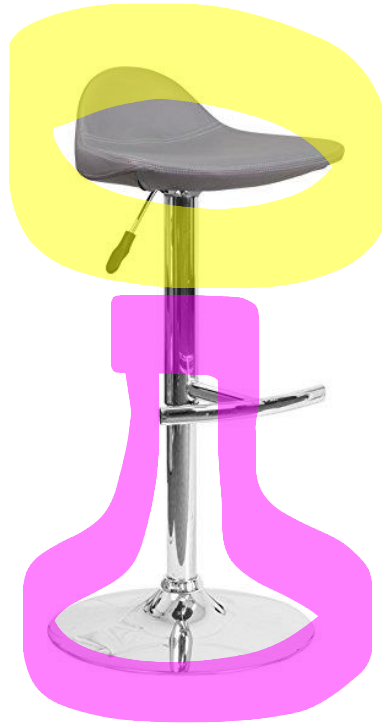
Missing Images



# Challenges: Weak Supervision

## Gray Vinyl Barstool

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Color Finish Gray

Style Contemporary

Adjustable Height Yes

Frame Material Metal

Don't know where the value *appears* in the input.

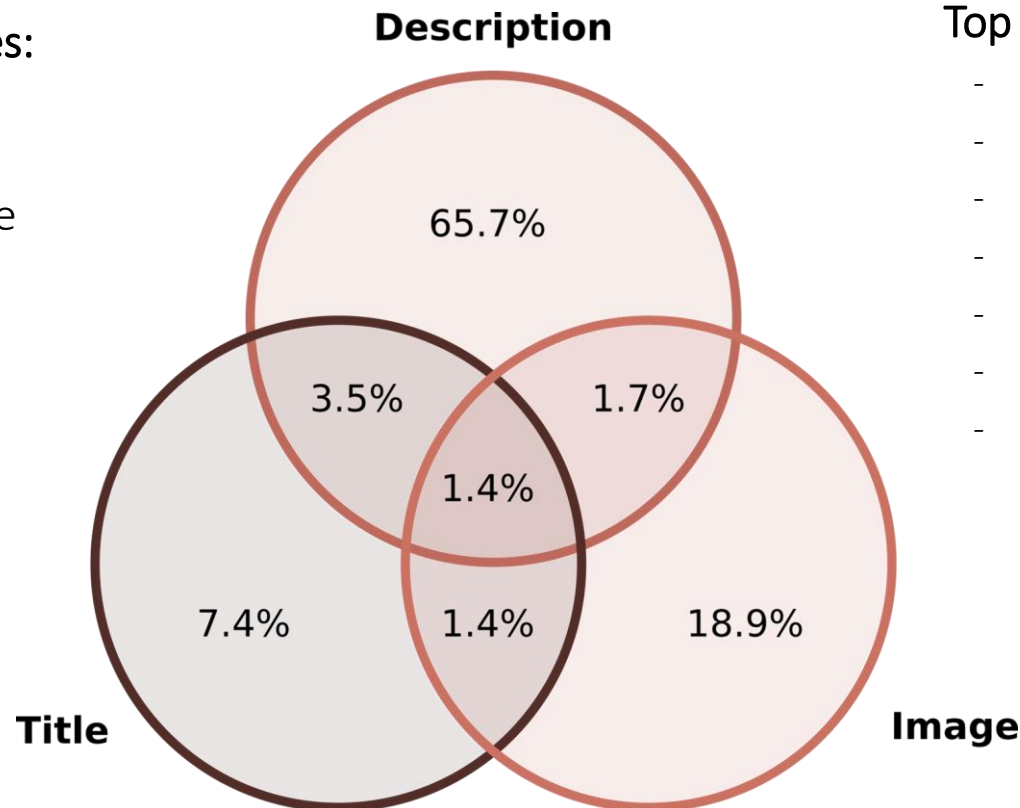
Don't even know IF the attribute has a value in the images/text.

# Data Quality Crowdsourcing Study

Only 46% of the queries answerable!

## Top Text Attributes:

- Color
- Quantity
- Product Type
- Size
- Year
- Finish
- Warranty



## Top Image Attributes:

- Color
- Product Type
- Shape
- Quantity
- Category
- Tool Type
- Exterior Color

# Evaluation

## Noisy Data

- Great for training: massive, realistic, challenging
- Flawed for evaluation: better models might look worse\*

## Gold Evaluation Corpus

- Crowd-annotated with verified, *queryable* values
- 2,238 attribute-value pairs annotated so far, more coming
- Multiple values that mean the same are still a problem

## Evaluation Metric, Accuracy@K

- Whether true *value* appears in the top-K predictions
- Required, since multiple values might be correct

\* So far, results only on noisy data

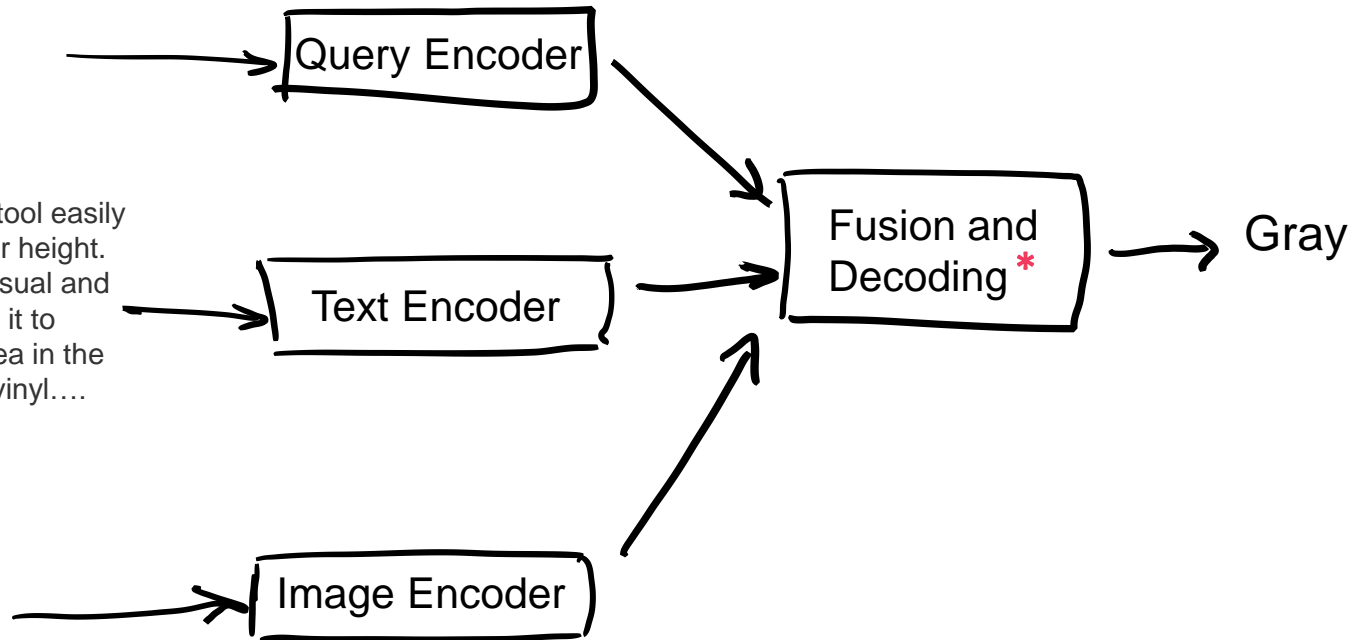


# Current (Baseline) Model

Color Finish

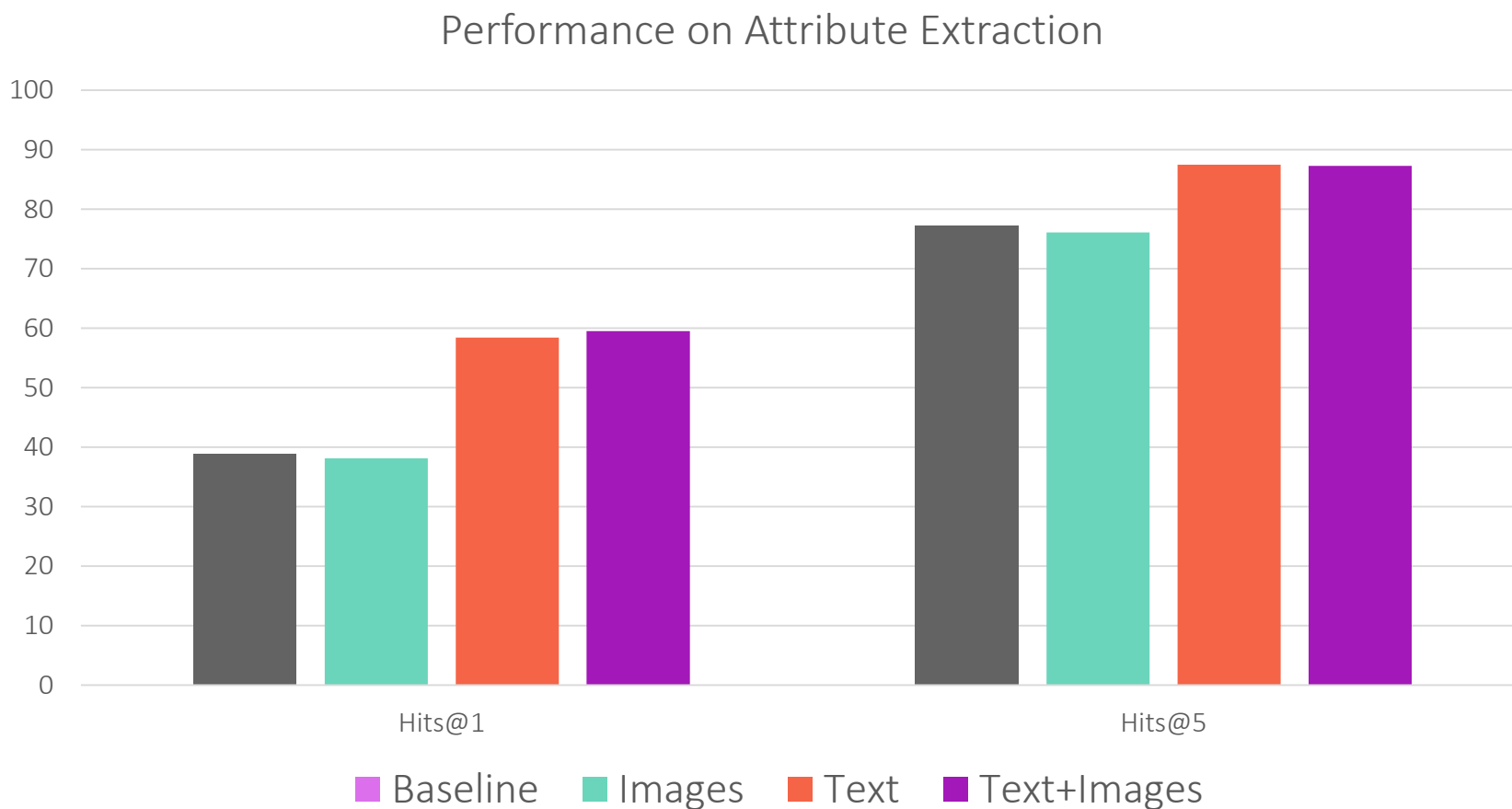
## Gray Vinyl Barstool

This sleek dual purpose stool easily adjusts from counter to bar height. The backless design is casual and contemporary which allow it to seamlessly accent any area in the home. The easy to clean vinyl....

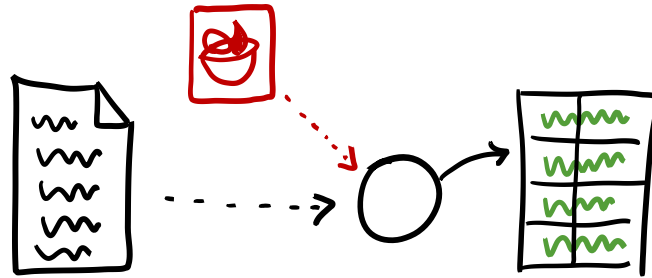


\* So far, concatenation works best

# Extraction Results



# Multimodal Attribute Extraction



**Task:** Given text and images about an entity, extract attributes

**Dataset:** Massive, diverse, open-domain dataset

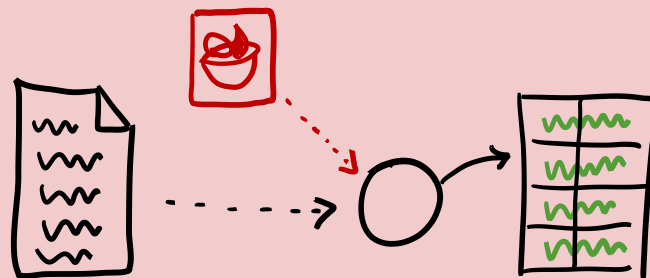
**Evaluation:** Curated, small, held-out dataset

**Baseline:** Shows the challenge, and promise, of the task

<https://rloganiv.github.io/mae/>

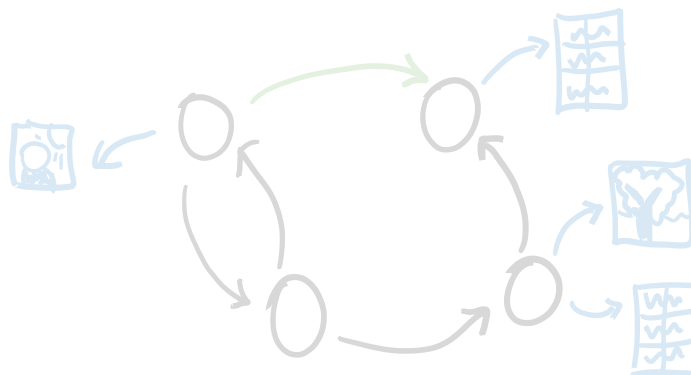
# Outline

## Attribute Extraction



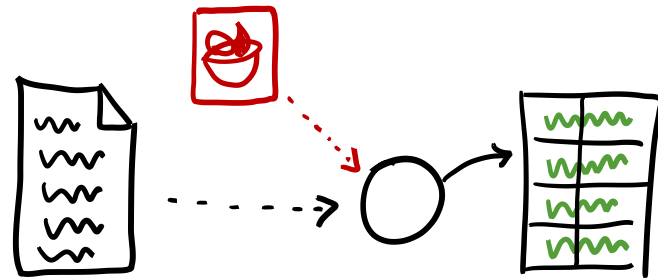
work with **Robert Logan**, Samuel Humeau, Mike Tung

## KB Completion

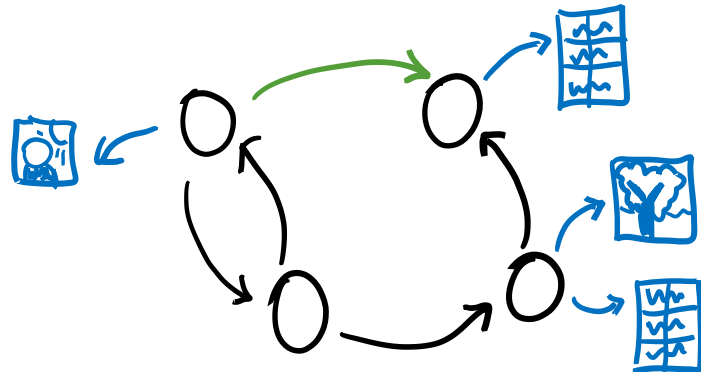


# Outline

Attribute Extraction

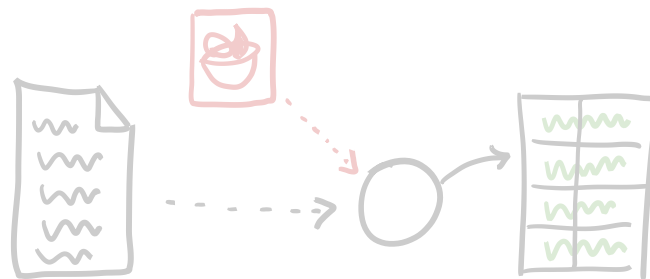


KB Completion

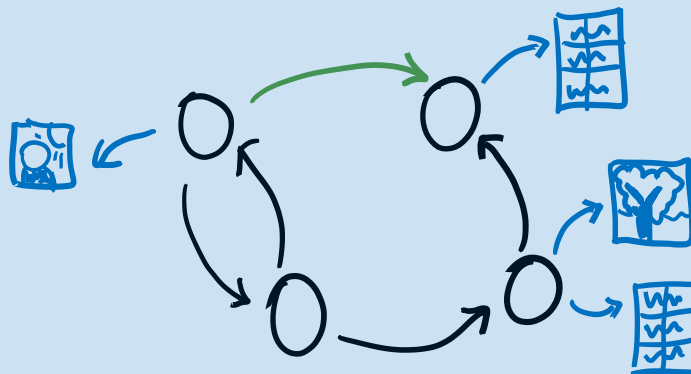


# Outline

Attribute Extraction



KB Completion



work with **Pouya Pezeshkpour**, Liyan Chen

# Knowledge Base Completion



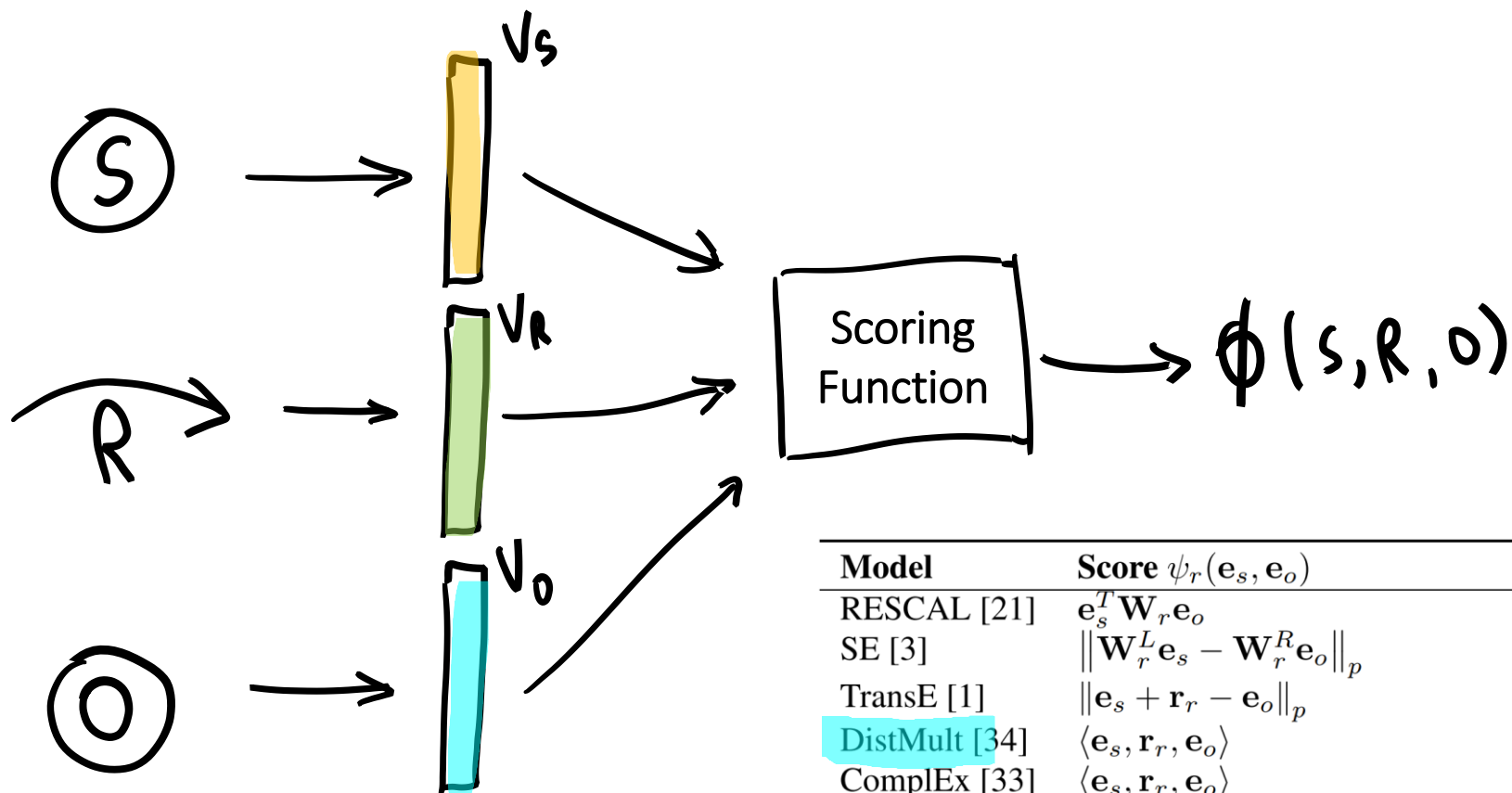
Entity Prediction



Link Prediction



# Knowledge Base Completion

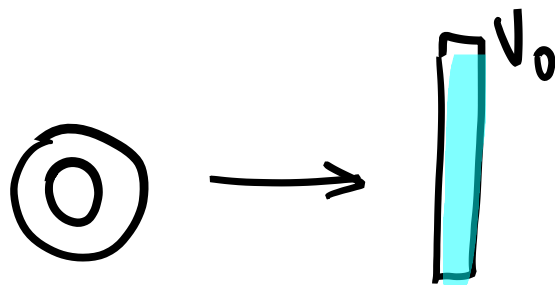


Model	Score $\psi_r(\mathbf{e}_s, \mathbf{e}_o)$
RESKAL [21]	$\mathbf{e}_s^T \mathbf{W}_r \mathbf{e}_o$
SE [3]	$\ \mathbf{W}_r^L \mathbf{e}_s - \mathbf{W}_r^R \mathbf{e}_o\ _p$
TransE [1]	$\ \mathbf{e}_s + \mathbf{r}_r - \mathbf{e}_o\ _p$
DistMult [34]	$\langle \mathbf{e}_s, \mathbf{r}_r, \mathbf{e}_o \rangle$
ComplEx [33]	$\langle \mathbf{e}_s, \mathbf{r}_r, \mathbf{e}_o \rangle$
ConvE	$f(\text{vec}(f([\overline{\mathbf{e}}_s; \overline{\mathbf{r}}_r] * \omega))) \mathbf{W}) \mathbf{e}_o$

Table from Dettmers, et al. (2017)



# Restrictions in the Model



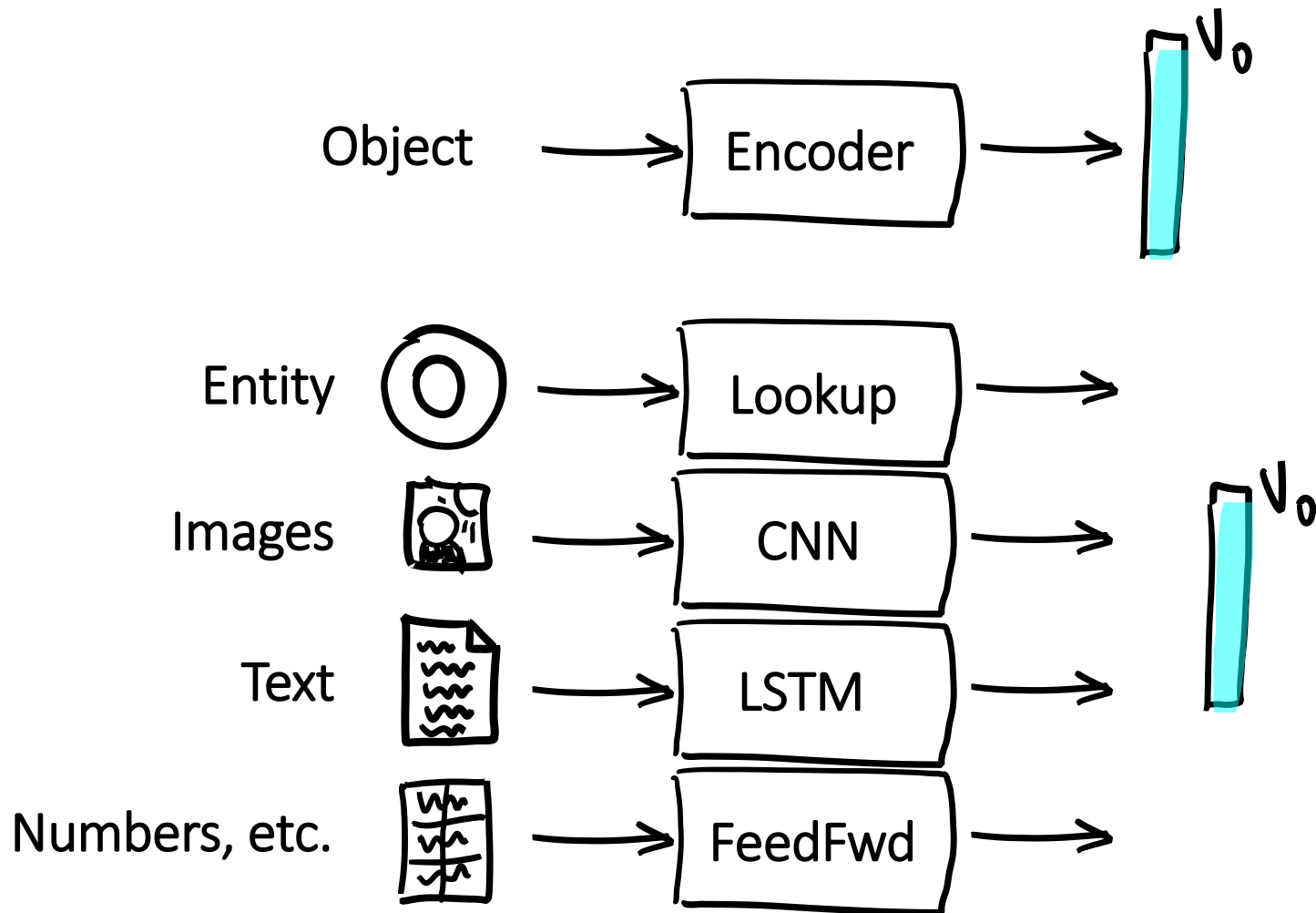
Each object has a vector representation:

- Limits number of objects
- Large number of parameters
- Is not compositional (doesn't generalize)

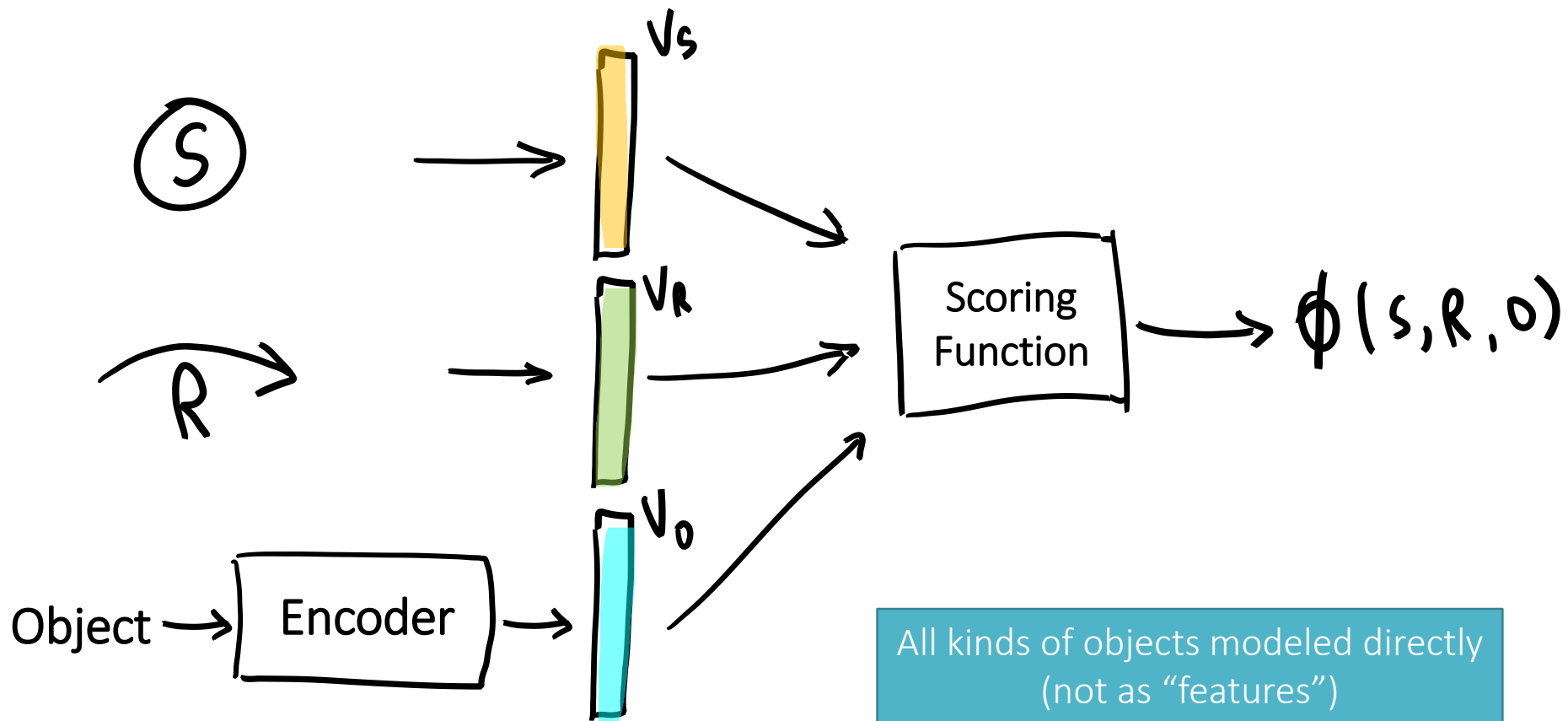
What about other kinds of objects?

- Dates and Numbers: should generalize
- Text: Names and Descriptions
- Images: Portraits, Posters, etc.

# Multimodal KB Embeddings



# Multimodal KB Embeddings

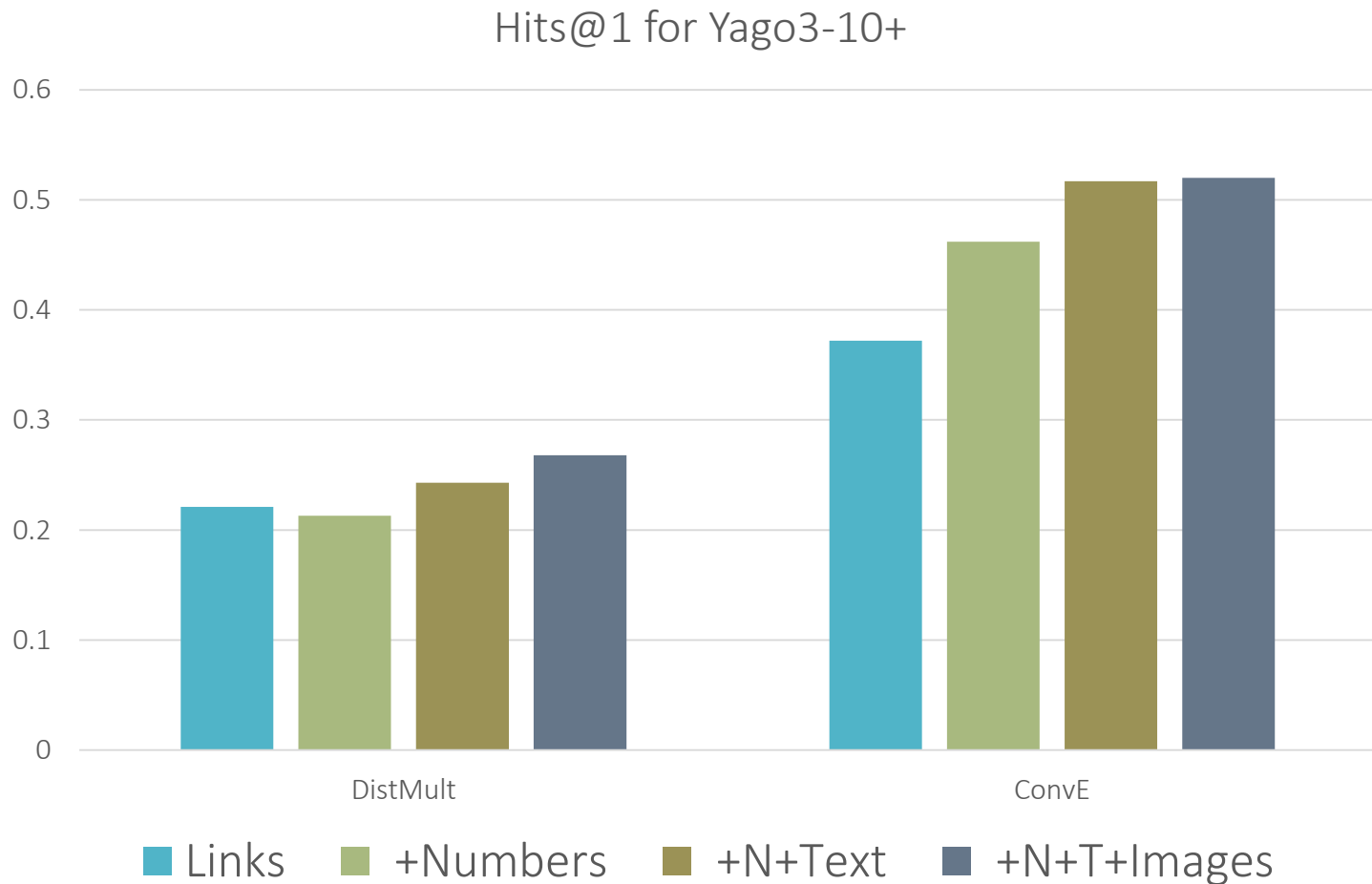


# Augmenting Existing Datasets

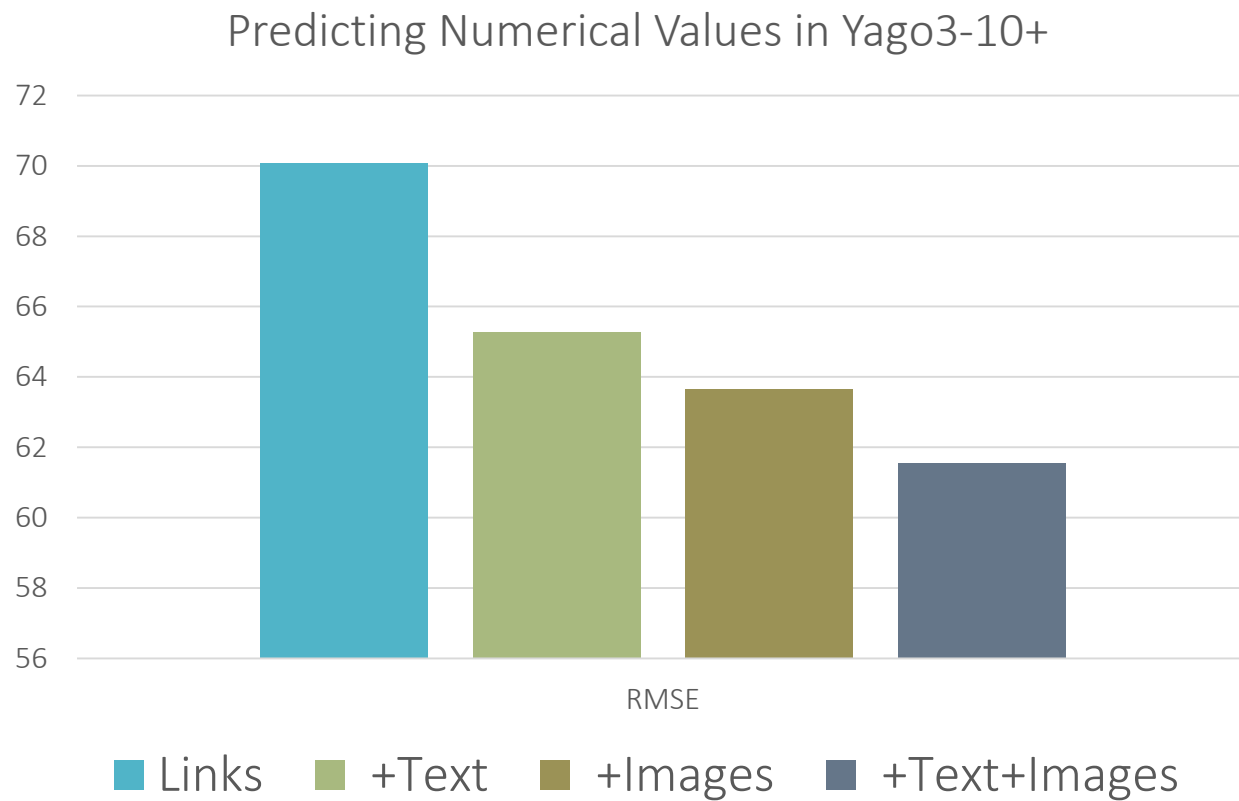
MovieLens-100k-plus	
Relations	13
Users	943
Movies	1682
Posters	1651
Ratings	100,000

YAGO3-10-plus	
Relations	37 → 45
Entities	123,182
Structure Triples	1,079,040
Numbers (Years)	1651
Descriptions	107,326
Images	61,246

# Link Prediction Results



# Predicting Multimodal Values



# Predicting Multimodal Values

“Die Hard”



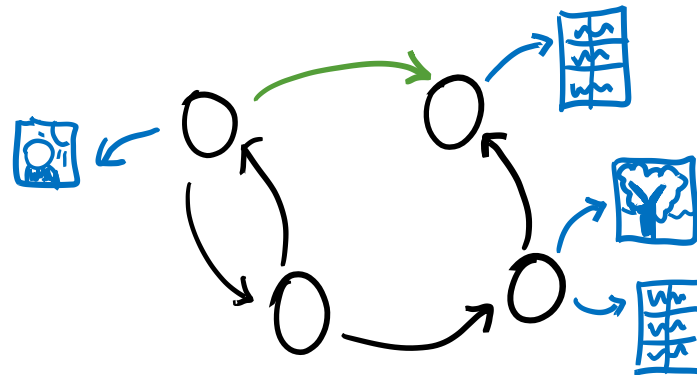
“Action, Thriller”

“The Band Wagon”, “Underground”, “Roseanna’s Grave”



“Drama, War”, “Action, Drama, War”, “Comedy, Drama, War”

# Multimodal KB Completion



**Task:** Given graph and other kinds of objects, predict links

**Dataset:** Extended existing datasets to introduce benchmarks

**Baseline:** Unique, multimodal model gets impressive gains

**Decoding:** Some promising results for decoding the objects

Code and datasets coming soon!



# Multimodal AKBC

Important to do now!

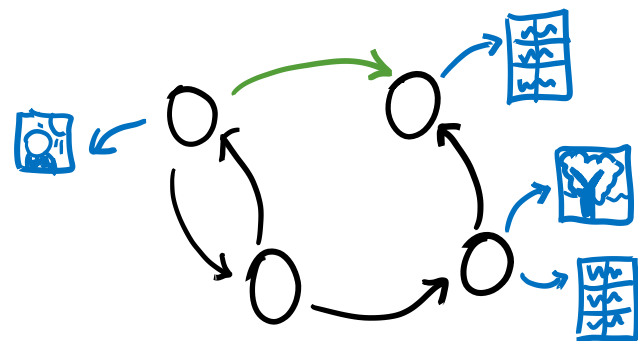
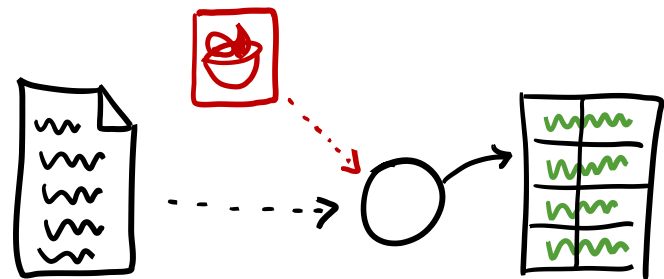
Introduced two multimodal tasks

- Attribute Extraction
- KB Completion

Datasets, metrics, and models

Future Work:

Tell us what you will do!



# Thank you!



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[@sameer\\_](#)