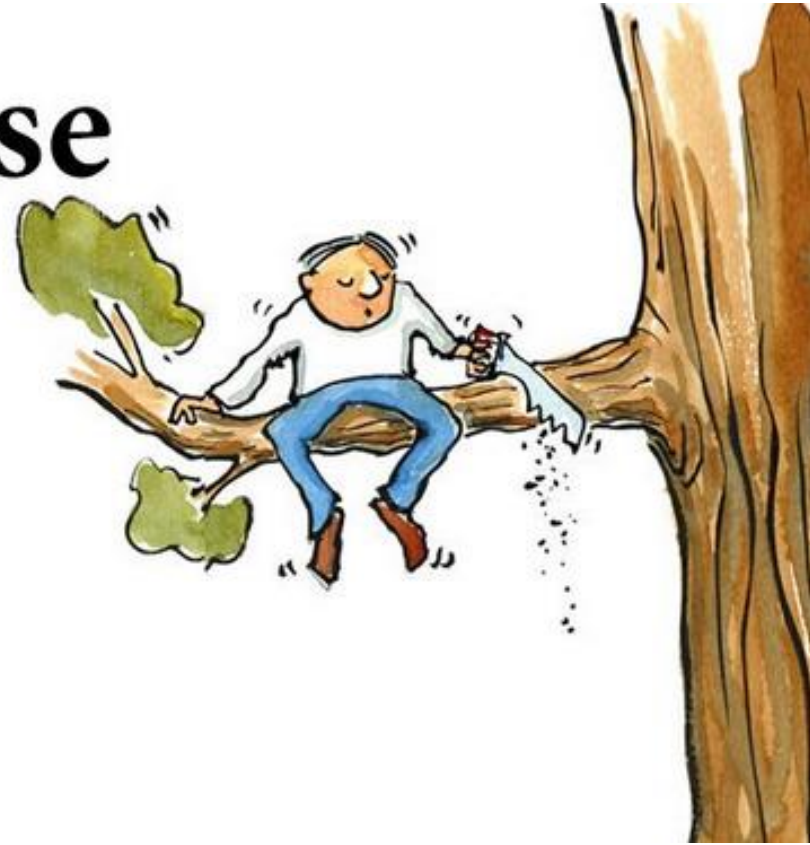


**Common sense
is not so
COMMON.**

- Voltaire



Commonsense Reasoning

Mohammad Asif Khan

Overview

Motivation

How to represent Commonsense: ConceptNet

Commonsense enriched word representation

KB Completion on ConceptNet

What is Commonsense?

Too obvious to say.

Ability to use it when appropriate.



What is Commonsense?

- *“Common sense is the collection of prejudices acquired by age eighteen.”—Albert Einstein*
- *“We tend to take commonsense thinking for granted, because we do not often recognize how intricate those processes are. Many things that everyone does are more complex than are many of those ‘expert’ skills that attract more attention and respect.” —Marvin Minsky*
 - For Instance, *“You cannot think about thinking without thinking about thinking about something.”—Seymour Papert*



This is George and his father.



This is George and his father.

Which is which?

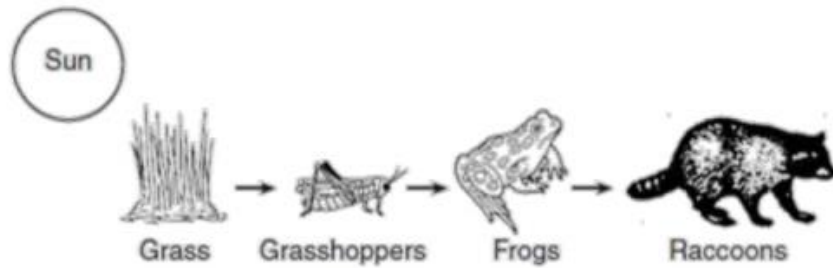
Commonsense Reasoning is Hard

- Lots of commonsense knowledge.

“If you stick a pin into a carrot, it leaves a hole.”
- Facts are not stated explicitly in text.

“If X is a father of Y, then Y is a child and X is older than Y.”

Human v/s Machine

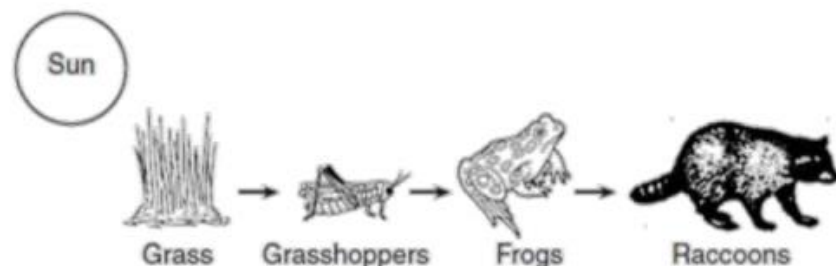


If all the frogs died, the raccoon population would most likely
(A) **decrease** (B) increase (C) remain the same



For roller-skate race, what is the best surface?
(A) sand (B) grass (C) **blacktop**

Human v/s Machine



If all the frogs died, the raccoon population would most likely
(A) **decrease** (B) increase (C) remain the same

Picture depicts food web. Arrow indicates consumes.
If frogs die, raccoons won't get food and die-- so their population will decrease.

Not seen those arrows enough so cannot generalize.
Haven't seen raccoons, frogs in a sentence frequently

Humans

Human - Machine
Knowledge Gap

Machines



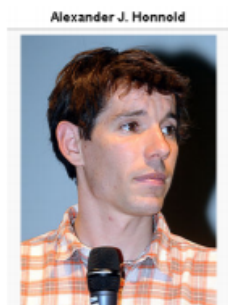
For roller-skate race, what is the best surface?
(A) sand (B) grass (C) **blacktop**

Roller skate is best on a smooth surface. Blacktop surfaces are shiny and shiny surfaces are smooth.

grass – related to – field – race , so “grass”
blacktop is not related to race.

Human v/s Machine

Machines



Alexander J. Honnold

Personal information	
Born	August 17, 1985 (age 29)
Education	UC Berkeley (dropped out)
Occupation	Professional rock climber
Climbing career	
Type of climber	<ul style="list-style-type: none">Free soloBig wall
Highest grade	Redpoint: 5.14c (8c+) Bouldering: V12 (8A+)
Known for	Big Wall Free Soloing Speed record on <i>The Nose</i> of El Capitan

Machines can surpass most humans on Encyclopedic knowledge about popular "named entities"



1 Rock

2 Hands

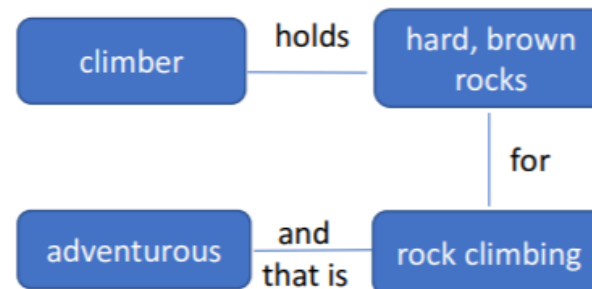
1 Person

2 Legs

Machines cannot surpass any human on commonsense knowledge about "common nouns"

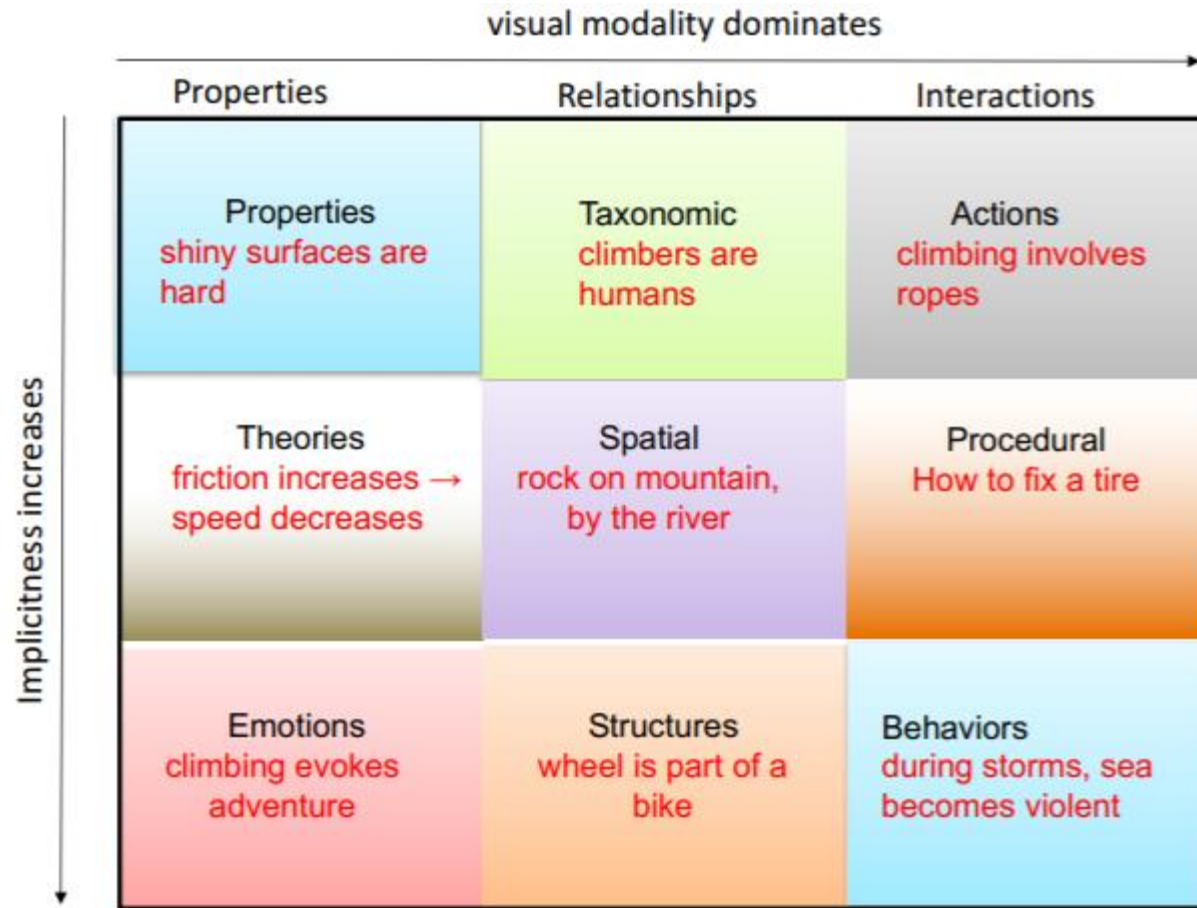
Humans

Personal information	
Born	?
Education	?
Occupation	?
Climbing career	
Type of climber	?
Highest grade	?
Known for	?



How we can categorize
commonsense?

Commonsense knowledge types

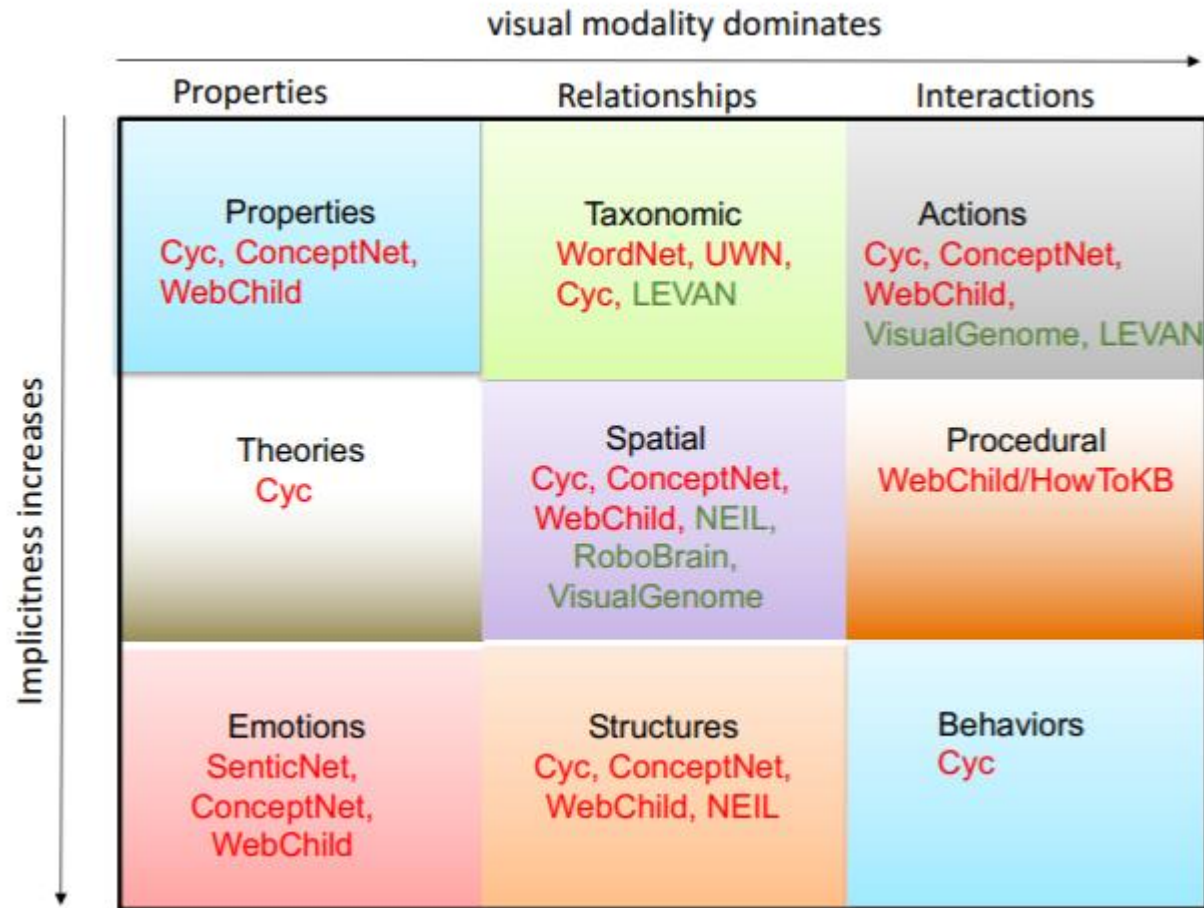




How we can
represent it?

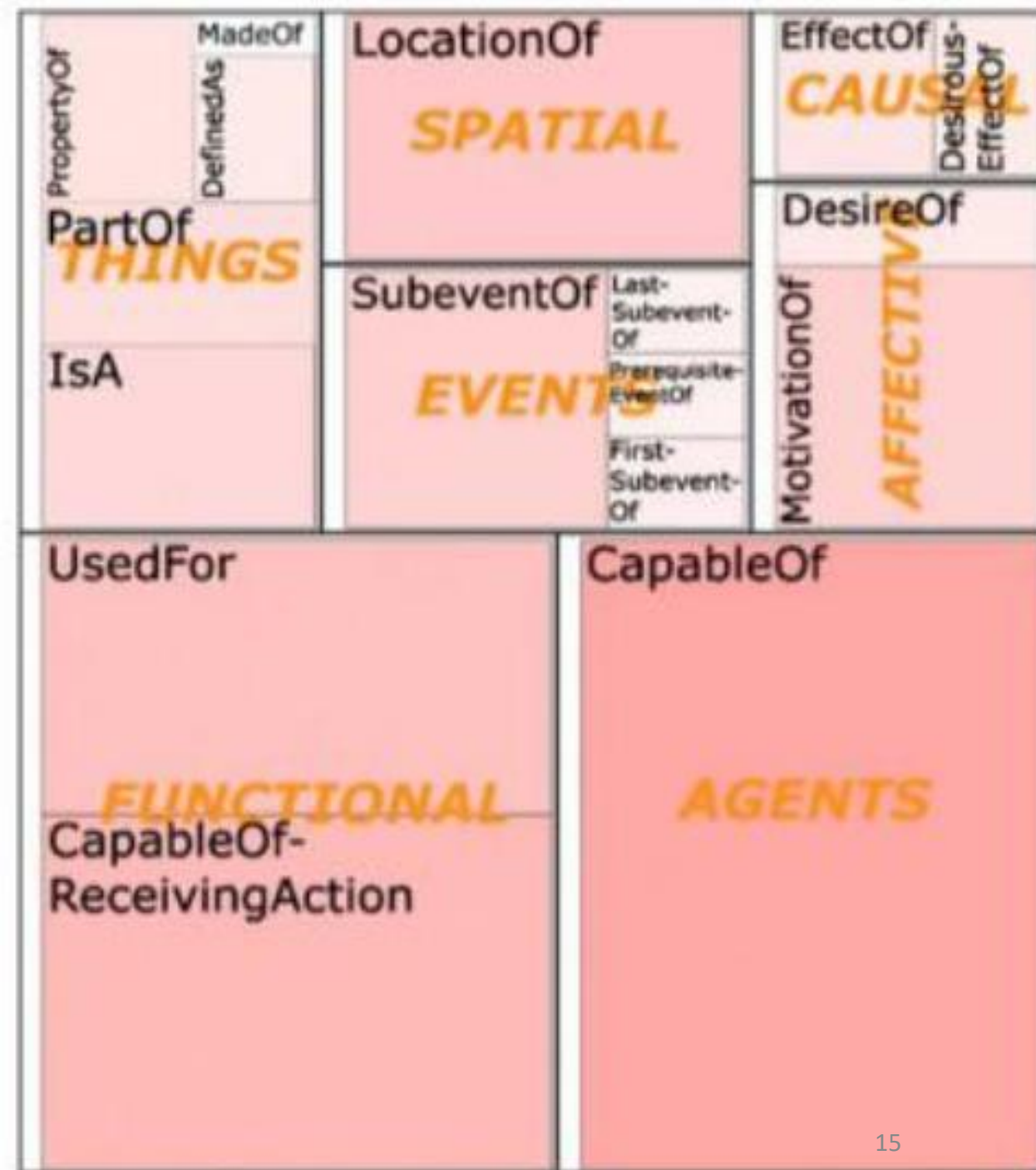


Commonsense KBs

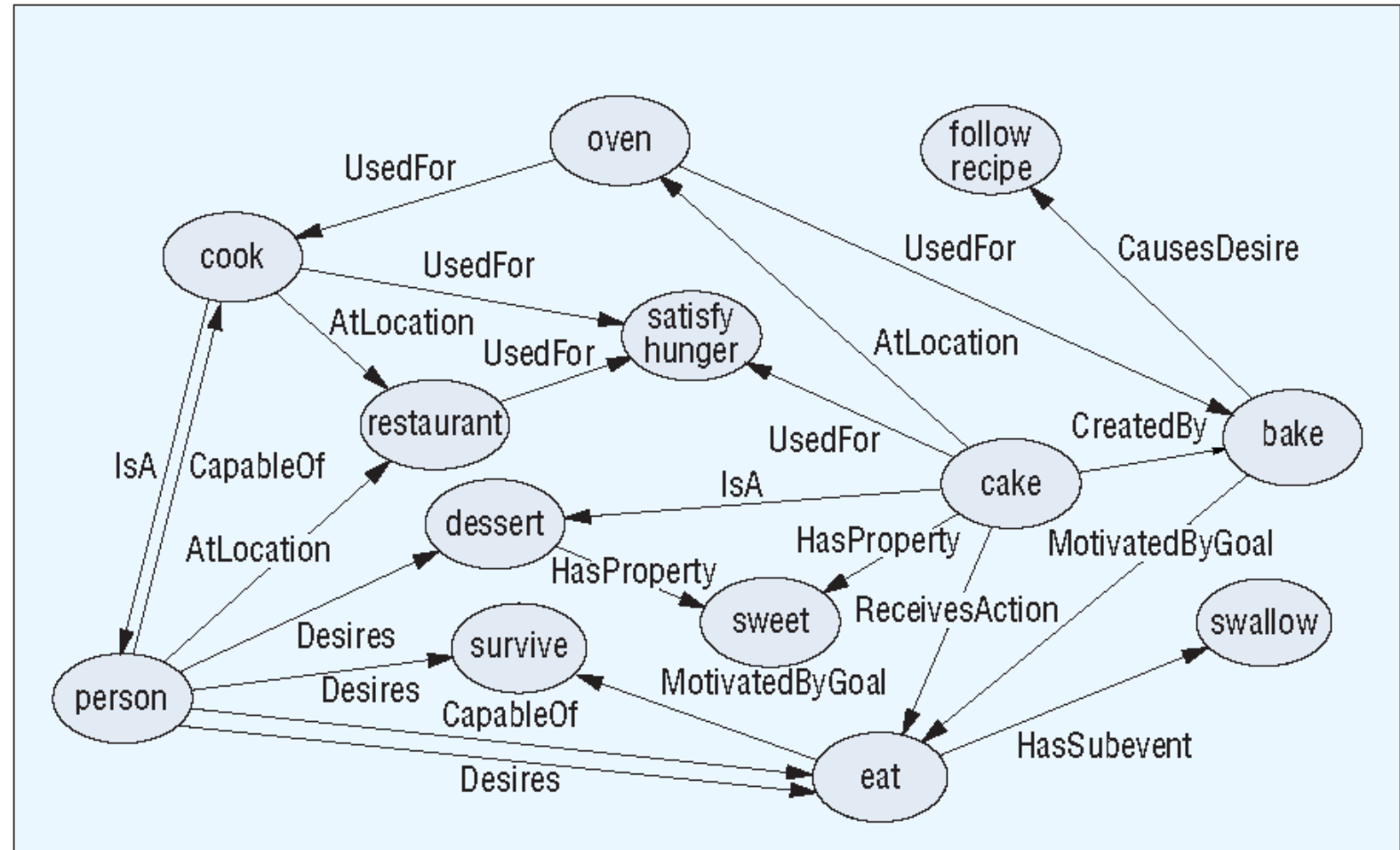


ConceptNet

- Freely available commonsense knowledge base.
- Supports many practical textual reasoning tasks over real-word documents.
- 1.6 million assertions, 20 relation types.



ConceptNet




Some Applications



MakeBelieve: Storytelling

A simple story example



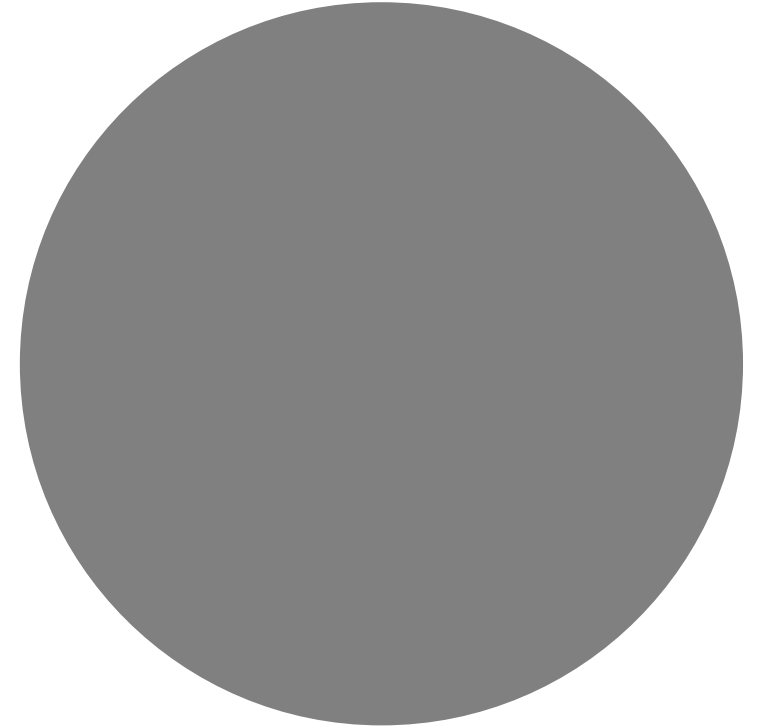
*“John became very lazy at work.
John lost his job. John decided to
get drunk. He started to commit
crimes. John went to prison. He
experienced bruises. John cried.
He looked at himself differently.”*

- Generated by [makebelieve](#)

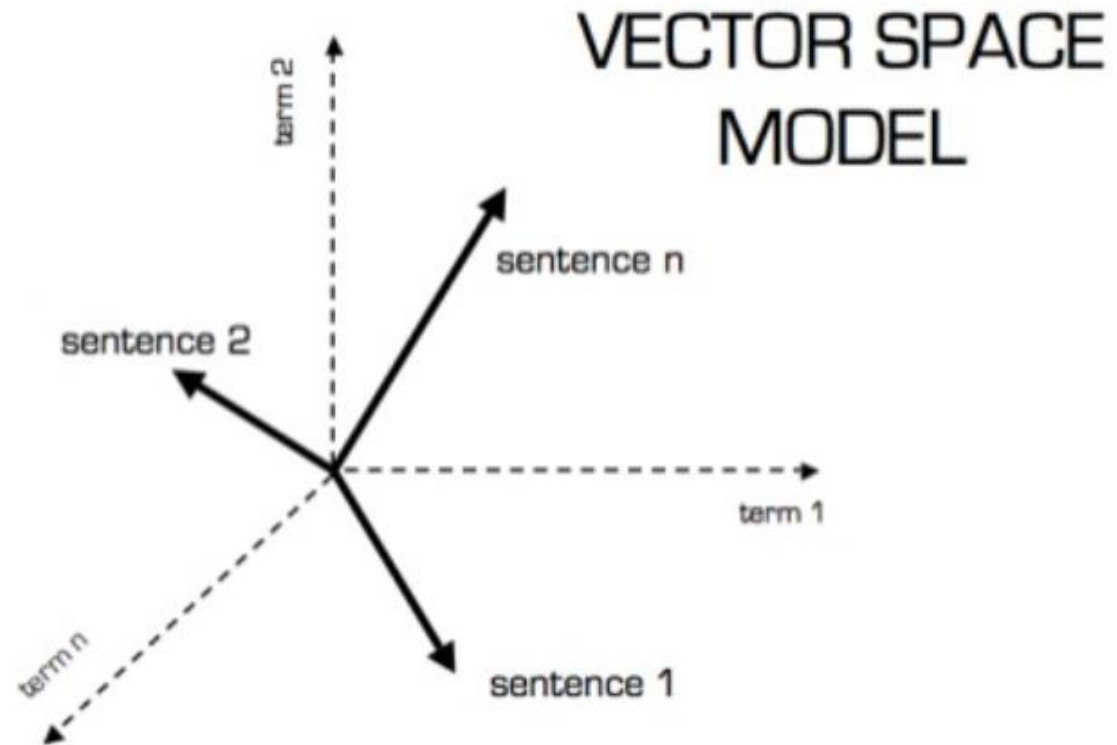
Open Issues: Self Driving Cars



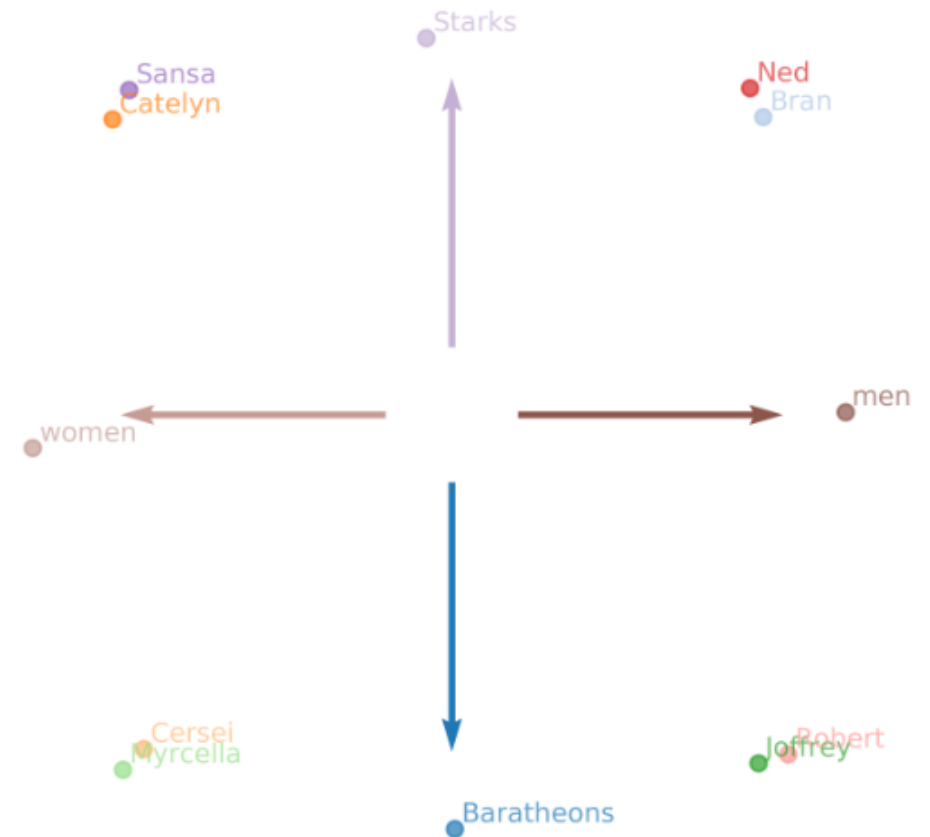
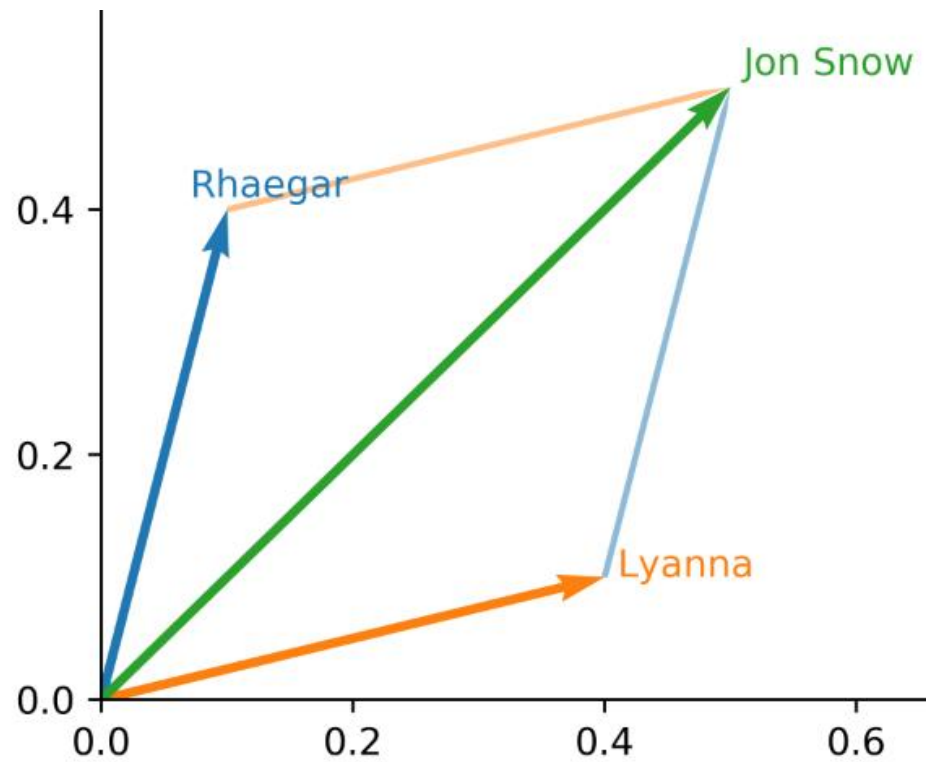
Commonsense enriched word representation



Vector Space Model

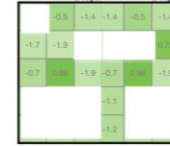


Similarity Space



Some Methods

$$M_{ij} = \frac{\# \text{ of word } i}{\# \text{ of word } i \text{ in doc } j}$$



document-word

$$SVD(M_{ij})$$



document-word

LSI + Dirichlet Prior



document-word

$$M_{ij} = \frac{\#(i, j) / n_{pairs}}{\#(i) / n_{words} \#(j) / n_{words}}$$

$$SVD(M_{ij})$$



word-word

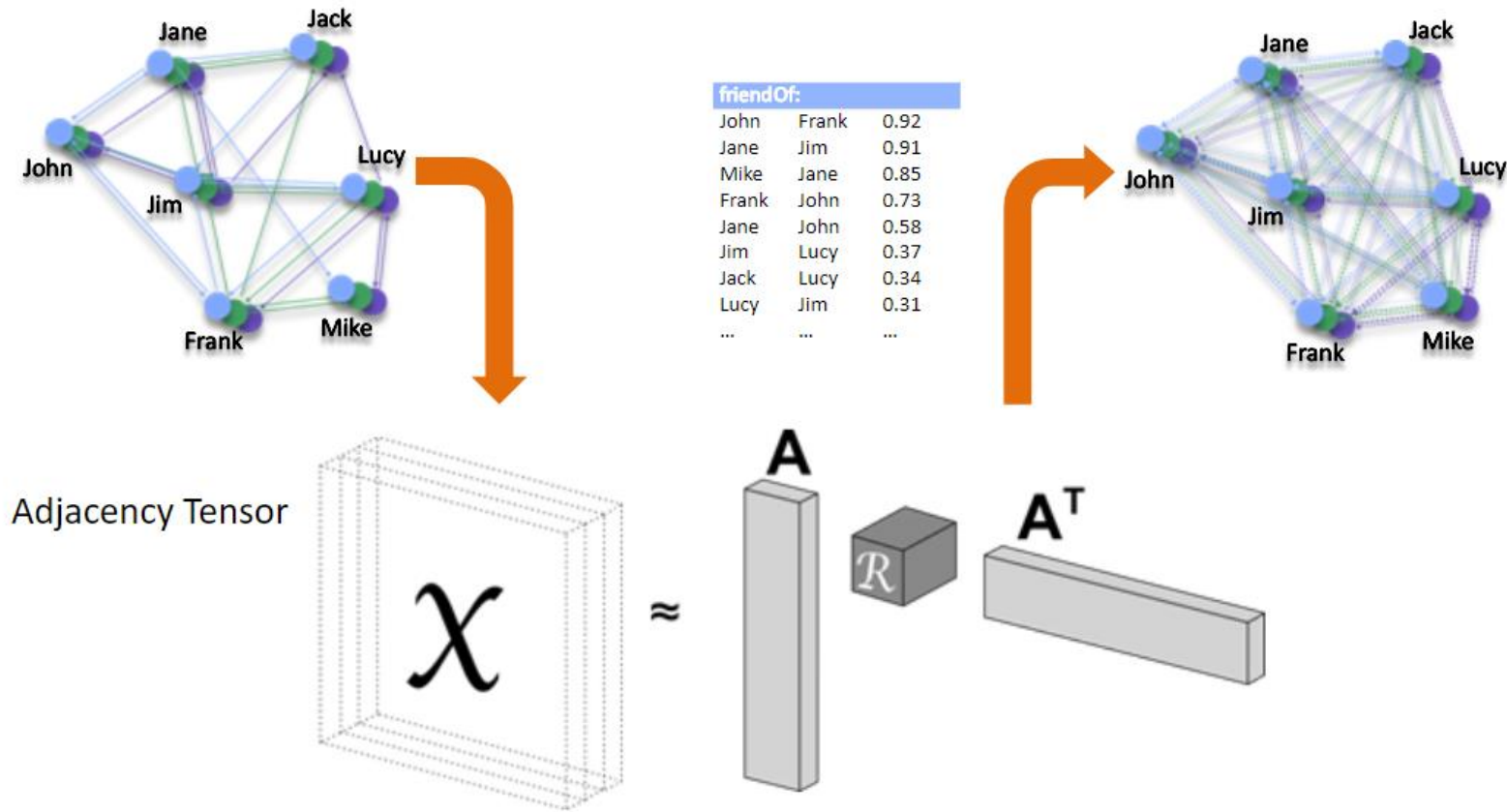
$$M_{ijk} = \frac{\#(i, j, k) / n_{triplets}}{\#(i) / n_{words} \#(j) / n_{words} \#(k) / n_{words}}$$

$$SVD(M_{ijk})$$



document-word-word

Knowledge Base Embedding (KBE)



Methods

Model	Scoring Function	Parameter Complexity
Unstructured	$\ \mathbf{h} - \mathbf{t}\ $	$n_e d$
Distance Model (SE)	$\ W_{rh}\mathbf{h} - W_{rt}\mathbf{t}\ ;$ $(W_{rh}, W_{rt}) \in \mathbb{R}^{d \times d}$	$n_e d + 2n_r d^2$
Single Layer Model	$\mathbf{u}_r^T \tanh(W_{rh}\mathbf{h} + W_{rt}\mathbf{t} + \mathbf{b}_r);$ $(W_{rh}, W_{rt}) \in \mathbb{R}^{s \times d}, (\mathbf{u}_r, \mathbf{b}_r) \in \mathbb{R}^s$	$n_e d + 2n_r(sd + s)$
Bilinear Model	$\mathbf{h}^T W_r \mathbf{t};$ $W_r \in \mathbb{R}^{d \times d}$	$n_e d + n_r d^2$
Neural Tensor Network	$\mathbf{u}_r^T \tanh(\mathbf{h}^T W_r \mathbf{t} + W_{rh}\mathbf{h} + W_{rt}\mathbf{t} + \mathbf{b}_r);$ $W_r \in \mathbb{R}^{d \times d \times s}, (W_{rh}, W_{rt}) \in \mathbb{R}^{s \times d}, (\mathbf{u}_r, \mathbf{b}_r) \in \mathbb{R}^s$	$n_e d + n_r(sd^2 + 2sd + 2s)$
TransE	$\ \mathbf{h} + \mathbf{r} - \mathbf{t}\ ;$ $\mathbf{r} \in \mathbb{R}^d$	$n_e d + n_r d$
TransM	$w_r \ \mathbf{h} + \mathbf{r} - \mathbf{t}\ ;$ $\mathbf{r} \in \mathbb{R}^d, w_r \in \mathbb{R}$	$n_e d + n_r d (+n_r)$

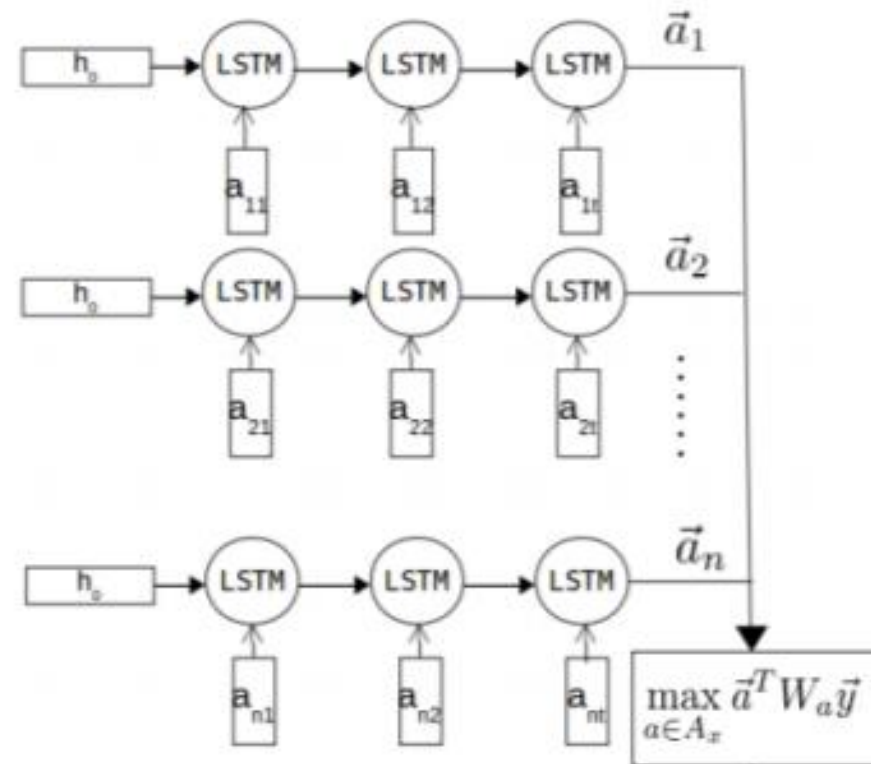
KBE: ConceptNet

- $\forall (h, r, t) \in \text{ConceptNet}$
 - $h = [\text{word}_1, \text{word}_2, \dots, \text{word}_n]$
 - $t = [\text{word}_1, \text{word}_2, \dots, \text{word}_m]$

ex: (*listen to radio, HasPrerequisite, tune in station*)

KBE: ConceptNet

- Word Averaging
- LSTM
- Temporal Convolution



KBs Completion.

relation	right term	conf.
MOTIVATEDBYGOAL	relax	3.3
USEDFOR	relaxation	2.6
MOTIVATEDBYGOAL	your muscle be sore	2.3
HASPREREQUISITE	go to spa	2.0
CAUSES	get pruny skin	1.6
HASPREREQUISITE	change into swim suit	1.6

Table 1: ConceptNet tuples with left term “soak in hotspring”; final column is confidence score.

Summary

- Commonsense important for general intelligence.
- ConceptNet: the largest freely commonsense database.
- Common sense enriched word embeddings.

What Next?

- Discussion on methods.
 - Tensor Factorization Methods.
 - Translational Methods.
 - Neural Network Based Methods.
- Demonstration on problems like KB Completion, sentence classification.

Questions.

Thank you! 😊

References

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- <https://github.com/commonsense/conceptnet5/wiki>
- <http://agents.media.mit.edu/projects/makebelieve/AAAI2002-makebelieve.pdf>