Commonsense Modeling with Commonsense Graphs

Yejin Choi

Paul G. Allen School of Computer Science & Engineering
University of Washington &
Allen Institute for Artificial Intelligence
Overview

- In this work, we investigate the problem of producing structured graph representations of visual scenes. Similar to object detection, we must predict a box around each object. Here, we also need to predict an edge (with one of several possible attributes) between each pair of objects.
From Recognition to Cognition: Visual Commonsense Reasoning

CVPR 2019

Rowan Zellers  Yonatan Bisk  Ali Farhadi  Me
Solving only a “dataset” without solving the underlying “task”!
Let’s bridge this gap!

Peters et al., 2018;
Devlin et al., 2018
Definition of Common Sense

- the basic level of **practical knowledge** and **reasoning**
- concerning **everyday situations** and **events**
- that are **commonly** shared among **most** people.

For example, it’s ok to keep the closet door open, but it’s not ok to keep the fridge door open, as the food inside might go bad.
Essential for humans to live and interact with each other in a reasonable and safe way.

Essential for AI to understand human needs and actions better.

For example, it’s ok to keep the closet door open, but it’s not ok to keep the fridge door open, as the food inside might go bad.
Completion

what happens when you stack kindling and logs in a fireplace and then drop some matches is that you typically start a sick. So, it's kind of ironic that the second day after my son was born, the fire in the living room had melted through the kindling. It's pretty neat.
Gary, try mosaickg.apps.allenai.org by typing "Gary stacks kindling and logs and drops some matches". Sorry I used deep learning... :)

Because PersonX **wanted**
- to start a fire
- to make a fire
- to start a fight
- none
- to get rid of something

Before, PersonX **needed**
- to get a lighter
- to have a lighter
- none
- to pick up a match
- to pick up the logs
Let’s bridge this gap!

Symbolic common sense graph
Neural commonsense representations
Reasoning engine with common sense
Constructing challenge datasets right
Got a Challenge Dataset?
1. Physical IQA
2. Social IQA
3. Visual Commonsense Reasoning
4. Abductive NLI
5. HellaSwag
6. Winogrande
7. Cosmos QA = A rainbow of MCS challenges
Adam walked with a much longer stride than Jason because [Adam / Jason] had much [taller/shorter] legs.

Adam saw Jason breaking into a house, [Adam / Jason] ran away [and called / to dodge] the police.

~44,000 Instances
Physical IQA

Test knowledge of affordances and physical attributes

~21,000 Instances

Q. What household item can I use to roll out clay?

Wine Bottle

Mixer
Context:
Their cat kept trying to escape out of the window, so Jan placed an obstacle in the way.

Question:
How would Jan feel afterwards?

- scared of losing the cat
- relieved for fixing the problem
- normal

~45,000 Instances
From Recognition to Cognition: Visual Commonsense Reasoning

CVPR 2019

Rowan Zellers
Yonatan Bisk
Ali Farhadi
Me
Why is [person4] pointing at [person1]?

a) He is telling [person3] that [person1] ordered the pancakes.
b) He just told a joke.
c) He is feeling accusatory towards [person1].
d) He is giving [person1] directions.
Why is [person4] pointing at [person1]?

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Why is [person4] pointing at [person1]?

a) He is telling [person3] that [person1] ordered the pancakes.

b) He just told a joke.

c) He is feeling accusatory towards [person1].

d) He is giving [person1] directions.

BECAUSE...

I chose a) because...

a) [person1] has the pancakes in front of him.

b) [person4] is taking everyone’s order and asked for clarification.

c) [person3] is looking at the pancakes and both she and [person2] are smiling slightly.

d) [person3] is delivering food to the table, and she might not know whose order is whose.
<table>
<thead>
<tr>
<th>Rank</th>
<th>Model</th>
<th>Q-&gt;A</th>
<th>QA-&gt;R</th>
<th>Q-&gt;AR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Human Performance</td>
<td>91.0</td>
<td>93.0</td>
<td>85.0</td>
</tr>
<tr>
<td></td>
<td>University of Washington</td>
<td></td>
<td></td>
<td>(Zellers et al. '18)</td>
</tr>
<tr>
<td>28</td>
<td>Recognition to Cognition Networks</td>
<td>65.1</td>
<td>67.3</td>
<td>44.0</td>
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<td></td>
<td>University of Washington</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><a href="https://github.com/rowanz/r2c">https://github.com/rowanz/r2c</a></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rank</td>
<td>Model Description</td>
<td>Precision</td>
<td>Recall</td>
<td>F1-Score</td>
</tr>
<tr>
<td>------</td>
<td>--------------------------------------------------</td>
<td>-----------</td>
<td>--------</td>
<td>----------</td>
</tr>
<tr>
<td>1</td>
<td>UNITER-large (ensemble) MS D365 AI</td>
<td>79.8</td>
<td>83.4</td>
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<tr>
<td>2</td>
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<td>80.8</td>
<td>62.8</td>
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<tr>
<td>3</td>
<td>ViLBERT (ensemble of 10 models) Georgia Tech &amp; Facebook AI</td>
<td>76.4</td>
<td>78.0</td>
<td>59.8</td>
</tr>
</tbody>
</table>

* Updated: September 30, 2019
* Updated: September 23, 2019
* Updated: August 9, 2019
A rainbow of MCS challenges:

1. Physical IQA
2. Social IQA
3. Visual Commonsense Reasoning
4. Abductive NLI
5. HellaSwag
6. Winogrande
7. Cosmos QA
Many AI systems perform well, but do so for questionable reasons.
An Adversarial Evaluation Framework of Composers—Critics

Composers $\pi$
- Human writers
- Language Models
- Commonsense Corpora
- LSMDC
- wikiHow
- ActivityNet

$P(\text{word|context})$

Matching algorithms

Critics $\xi$
- Human validators
- Discriminative Models

Constraints

\[\text{Valid} \times \text{Invalid}\]
**HellaSwag:** Can a Machine Really Finish Your Sentence?

What happened with SWAG? **TLDR:**

1. dataset must be debiased (by algorithms)
2. dataset must evolve (with the evolving SOTA)
Adversarial Filtering
Train $t_1$

Test $t_1$

Correct Answer

Potential Incorrect Answers

$\mathcal{f}_{\theta}$

(the filtering model)
We’ll repeat this until convergence!

<table>
<thead>
<tr>
<th>Correct Answer</th>
<th>Potential Incorrect Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>( x^+_{1} )</td>
<td>( x^-_{1,1} )</td>
</tr>
<tr>
<td>( x^+_{2} )</td>
<td>( x^-_{2,1} )</td>
</tr>
<tr>
<td>( x^-_{1,3} )</td>
<td>( x^-_{1,4} )</td>
</tr>
<tr>
<td>( x^-_{2,3} )</td>
<td>( x^-_{2,4} )</td>
</tr>
<tr>
<td>( x^+_{3} )</td>
<td>( x^-_{3,1} )</td>
</tr>
<tr>
<td>( x^+_{4} )</td>
<td>( x^-_{3,4} )</td>
</tr>
<tr>
<td>( x^+_{5} )</td>
<td>( x^-_{4,4} )</td>
</tr>
<tr>
<td>( x^+_{6} )</td>
<td>( x^-_{5,4} )</td>
</tr>
<tr>
<td>( x^+_{6} )</td>
<td>( x^-_{6,1} )</td>
</tr>
<tr>
<td>( x^+_{6} )</td>
<td>( x^-_{6,4} )</td>
</tr>
</tbody>
</table>

Test \( t_2 \) | Train \( t_2 \)
An Adversarial Evaluation Framework of Composers—Critics
Pre GPT and BERT era (swag, 2018)
Post GPT and BERT era (hellaswag 2019)

Diagram showing the interaction between Composers $\pi$ and Critics $\xi$. Composers include human writers and language models, while Critics include human validators and discriminative models. The relationship is depicted through arrows indicating the flow of information and interaction between the two groups.
Post GPT and BERT era (2020?)

Composers $\pi$
- Human writers
- Language Models
- $P(\text{word}|\text{context})$

Critics $\xi$
- Human validators
- Discriminative Models

Grover

XLNet
Benchmarks must evolve!

How do we check if a model only solved a “dataset” without solving an underlying task? Try adversarial evaluation!

rowanzellers.com/hellaswag
Adversarial Filters of Dataset Biases

In submission 2019

Ronan Le Bras
Swabha Swayamdipta
Chandra Bhagavatula
Rowan Zellers
Matt Peters
Ashish Sabharwal
Yejin Choi
- **SWAG** (Zellers et al., 2018)
- **HellaSWAG** (Zellers et al., 2019)

- **Adversarial Filters of Dataset Biases**
  (Le Bras et al., 2019, in submission)
Let's bridge this gap!

- Symbolic common sense graph
- Neural commonsense representations
- Reasoning engine with common sense
- Constructing challenge datasets right
ATOMIC: An Atlas of Machine Commonsense for If-Then Reasoning

AAAI 2019

Maarten Sap

Ronan Le Bras  Emily Allaway  Chandra Bhagavatula  Nicholas Lourie  Hannah Rashkin  Brendan Roof  Noah Smith  Me
X repels Y’s attack

- X wanted to protect others
- X wanted to save themselves
- X wanted to train hard
- X needs to know self-defense
- X is skilled
- X is brave
- X is strong
- X is seen as

before, X needed to

- because X wanted to

as a result, X wants
- X wants to file a police report
- X wants to leave the scene

as a result, X feels
- X feels angry
- X feels tired

has an effect on X
- X’s heart races
- X gains an enemy
- X gains

has an effect on Y
- Y feels
goes

as a result, Y wants
- Y feels weak
- Y feels ashamed
- Y feels run away
- Y wants to run away
- Y wants to go back
- Y gets hurt
- Y wants to attack X again
**Causes**

- X wanted to protect others
- X wanted to save themselves
- X needs to train hard
- X needs to know self-defense

**Effects**

- X repels Y’s attack
- X is skilled
- X is brave
- X is strong
- X feels angry
- X feels tired
- X’s heart races
- X gains an enemy
- X gains the upper hand
- Y feels weak
- Y feels ashamed
- Y wants to run home
- Y wants to attack X again
X repels Y’s attack

X wanted to protect others
X wanted to save themselves

X needs to train hard
X needs to know self-defense

before, X wanted to
because X wanted to

X is skilled
X is strong
X is brave

X is seen as

X feels
X feels angry
X feels tired

X’s heart races
X gains an enemy

as a result, X feels

Y feels weak
Y feels ashamed

as a result, Y feels

Y wants to run home
Y wants to attack X again

as a result, Y wants

Dynamic

Static
“Cause and Effect”

“Deep learning, I see they’re all stuck there on the level of associations. Curve fitting.”

“To build truly intelligent machines, teach them cause and effect”
880,000 triples for AI systems to reason about causes and effects of everyday situations.
Existing commonsense knowledge bases

Knowledge of “what”
(taxonomic: A isA B; Davis and Marcus, 2015)

Represented in symbolic logic

\[
event := \text{forall (e)} \iff (event \ e) \text{ (or (exists (e1 e2)) (and (nequal e1 e2) (change’ e1 e2))) (exists (e1) (subevent e1 e)))}
\]

- 99% taxonomic
- 98% taxonomic

OpenCyc
(Lenat, 1995)

ConceptNet
(Liu & Singh, 2004)

EventNet
(Espinosa & Lieberman, 2005)

Formal Theory of Commonsense Psychology
(Gordon & Hobbs, 2017)

Knowledge of “why” and “how”
(inferential: causes and effects)

Represented in natural language
(how humans talk and think)

ATOMIC (this work)
(Sap et al.; 2019)
How to acquire causes and effects at scale?

From unlabeled text?

- Reporting bias (Gordon & Van Durme, 2013)
- Commonsense knowledge is not often written (Grice, 1975)

**ATOMIC**: Crowdsourced commonsense knowledge around event prompts using natural language

Browse ATOMIC: https://tinyurl.com/atomic-commonsense
Let’s bridge this gap!

Symbolic commonsense graph

Neural commonsense representations

Reasoning engine with common sense

Constructing challenge datasets right
COMeT: Commonsense Transformers for Automatic Knowledge Graph Construction

ACL 2019

Antoine Bosselut

Hannah Rashkin

Maarten Sap

Chaitanya Malaviya

Asli Çelikyilmaz

Me
Can we reason about commonsense knowledge without storing all of them explicitly?

Transfer learning from language (self-supervised) to knowledge (supervised)?

880,000 triples for AI systems to reason about causes and effects of everyday situations
Goal: to teach models to reason about causes and effects of new ATOMIC events.
COMeT

Transfer learning from language to knowledge!

Reporting bias issues, but provides signal about which events are similar
PersonX sails across the Atlantic

context event

<xNeed>

desired common sense inference

have a sailboat

commonsense prediction
COMeT

PersonX sails across the Atlantic <xNeed> have a sail boat
COMET on ATOMIC
<table>
<thead>
<tr>
<th>Precision</th>
<th>Human Eval on Machine Prediction</th>
<th>Human Eval on Human Prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>77.53</td>
<td>86.18</td>
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</tbody>
</table>
X holds out X’s hand to Y
X meets Y’s eyes
X eats red meat
X makes crafts
X takes Y’s head off
X pisses on Y’s bonfire
X spoils somebody rotten
X gives Y some pills

X explains Y’s reasons

X gives Y everything
X eats pancakes
X makes ___ at work
X gives Y’s friend ___
X goes ___ with friends
X gets all the supplies

xAttr    helpful
xAttr    intense
xEffect   gets fat
xEffect   gets dirty
oEffect   bleeds
oEffect   gets burned
xIntent   to be mean
xIntent   to help

xNeed    to know Y
to buy something
satisfied
proud
grateful
happy
to make a list
<table>
<thead>
<tr>
<th>Event</th>
<th>xAttr/Intent/Need/React/Effect/Want</th>
<th>xAttr/Int...</th>
<th>oReact</th>
</tr>
</thead>
<tbody>
<tr>
<td>X holds out X’s hand to Y</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X meets Y’s eyes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X eats red meat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X makes crafts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X takes Y’s head off</td>
<td>oEffect: bleeds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X pisses on Y’s bonfire</td>
<td>oEffect: gets burned</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X spoils somebody rotten</td>
<td>xIntent: to be mean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X gives Y some pills</td>
<td>xIntent: to help</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X explains Y’s reasons</td>
<td>xNeed: to know Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X gives Y everything</td>
<td>xNeed: to buy something</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X eats pancakes</td>
<td>xReact: satisfied</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X makes ___ at work</td>
<td>xReact: proud</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X gives Y’s friend ___</td>
<td>oReact: grateful</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X goes ___ with friends</td>
<td>oReact: happy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X gets all the supplies</td>
<td>xWant: to make a list</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Action</td>
<td>Type</td>
<td>Description</td>
<td></td>
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<tr>
<td>---------------------------------------------</td>
<td>------</td>
<td>----------------------</td>
<td></td>
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<tr>
<td>X holds out X’s hand to Y</td>
<td>xAttr</td>
<td>helpful</td>
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<tr>
<td>X meets Y’s eyes</td>
<td>xAttr</td>
<td>intense</td>
<td></td>
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<tr>
<td>X eats red meat</td>
<td>xEffect</td>
<td>gets fat</td>
<td></td>
</tr>
<tr>
<td>X makes crafts</td>
<td>xEffect</td>
<td>gets dirty</td>
<td></td>
</tr>
<tr>
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<td>oEffect</td>
<td>bleeds</td>
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</tr>
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<td>xIntent</td>
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<td>xIntent</td>
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<td>xNeed</td>
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</tr>
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<td>X gives Y everything</td>
<td>xNeed</td>
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<td></td>
</tr>
<tr>
<td>X eats pancakes</td>
<td>xReact</td>
<td>satisfied</td>
<td></td>
</tr>
<tr>
<td>X makes ___ at work</td>
<td>xReact</td>
<td>proud</td>
<td></td>
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<tr>
<td>X gives Y’s friend ___</td>
<td>oReact</td>
<td>grateful</td>
<td></td>
</tr>
<tr>
<td>X goes ___ with friends</td>
<td>oReact</td>
<td>happy</td>
<td></td>
</tr>
<tr>
<td>X gets all the supplies</td>
<td>xWant</td>
<td>to make a list</td>
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</table>
COMET on ConceptNet
<table>
<thead>
<tr>
<th>Human Eval on</th>
<th>Human Eval on</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMET Prediction</td>
<td>Human Prediction</td>
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<tr>
<td>91.69</td>
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<tr>
<td>Word</td>
<td>Relation</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>piece</td>
<td>PartOf</td>
</tr>
<tr>
<td>mango</td>
<td>IsA</td>
</tr>
<tr>
<td>maine</td>
<td>IsA</td>
</tr>
<tr>
<td>happiness</td>
<td>IsA</td>
</tr>
<tr>
<td>planet</td>
<td>AtLocation</td>
</tr>
<tr>
<td>dust</td>
<td>AtLocation</td>
</tr>
<tr>
<td>puzzle</td>
<td>AtLocation</td>
</tr>
<tr>
<td>sing</td>
<td>Causes</td>
</tr>
<tr>
<td>doctor</td>
<td>CapableOf</td>
</tr>
<tr>
<td>dove</td>
<td>SymbolOf</td>
</tr>
<tr>
<td>bird bone</td>
<td>HasProperty</td>
</tr>
<tr>
<td>yard</td>
<td>UsedFor</td>
</tr>
<tr>
<td>get pay</td>
<td>HasPrerequisite</td>
</tr>
<tr>
<td>play game</td>
<td>HasPrerequisite</td>
</tr>
<tr>
<td>live</td>
<td>HasLastSubEvent</td>
</tr>
<tr>
<td>sit down</td>
<td>MotivatedByGoal</td>
</tr>
</tbody>
</table>
piece PartOf machine
mango IsA fruit
maine IsA state
happiness IsA feel
planet AtLocation space
dust AtLocation fridge
puzzle AtLocation your mind
sing Causes you feel good
doctor CapableOf save life
dove SymbolOf purity
bird bone HasProperty fragile
yard UsedFor play game
get pay HasPrerequisite work
play game HasPrerequisite have game
live HasLastSubEvent die
sit down MotivatedByGoal you be tire
COMET can reason about **compositional** situations

<table>
<thead>
<tr>
<th>Situation (Input)</th>
<th>Relation</th>
<th>Prediction!</th>
</tr>
</thead>
<tbody>
<tr>
<td>man with axe</td>
<td>CapableOf</td>
<td>chop firewood</td>
</tr>
<tr>
<td>man with axe <strong>and</strong> a mask</td>
<td>CapableOf</td>
<td>cut down tree</td>
</tr>
<tr>
<td>man with axe <strong>and</strong> a mask <strong>in a house</strong></td>
<td>CapableOf</td>
<td>murder</td>
</tr>
</tbody>
</table>
COMeT
A knowledge base construction engine that learns to produce new nodes and connections in commonsense knowledge... (More)
[read the paper]

ATOMIC
An atlas of everyday commonsense reasoning, organized through 877k textual descriptions of inferential knowledge... (More)
[read the paper] [download the data]

Explore
Type in an event (e.g. “PersonX puts PersonX’s trust in PersonY”)
Alex drives his sister to the mall
Alex drives his sister to the mall

Because PersonX **wanted**
- to be helpful
- to go shopping
- to be nice
- to make her happy
- to spend time with her

Before, PersonX **needed**
- get in the car
- to start the car
- to have a car
- a car
- to get in the car

PersonX is **seen as**
- helpful
- caring
- generous
- kind
- thoughtful
Alex drives his sister to the mall

As a result, PersonX feels
- happy
- helpful
- excited
- satisfied
- generous

As a result, PersonX wants
- to go shopping
- to shop
- to pick up their sister
- to buy her a gift
- to go to the mall

PersonX then
- gets into trouble
- gets into a car accident
- gets thanked
- none
- drives
John gets into an accident
John gets into an accident

As a result, PersonX feels:
- hurt
- scared
- upset
- sad
- worried

As a result, PersonX wants:
- to call 911
- call 911
- get medical attention
- to cry
- to get medical help

PersonX then:
- gets hurt
- is injured
- personX is injured
- bleeds
- cries
John gets into an accident

As a result, others feel
- none
- worried
- sad
- scared
- upset

As a result, others want
- to call the police
- to help him
- none
- to help them
- to make sure they are ok

Others then
- none
- gets hurt
- gets injured
- bleeds
Sanja rides into the sunset on a motorcycle after solving AI.
Sanja rides into the sunset on a motorcycle after solving AI.

Effects on PersonX

As a result, PersonX feels
- happy
- excited
- satisfied
- thrilled
- elated

As a result, PersonX wants
- to have fun
- to get off the motorcycle
- to enjoy
- to enjoy the beauty
- to go to the beach

PersonX then
- gets a sunburn
- gets hurt
- personx gets a sunburn
- none
- smiles
Gary breaks the world record for most controversial tweet.

- Causes for PersonX
  - Because PersonX wanted
    - to be famous
    - to prove his fame
    - to make a difference
    - to be the best
  - Before, PersonX needed
    - to do research
    - to write a book
    - to write a magazine article
    - none
    - to write a blog post

- Attributes of PersonX
  - PersonX is seen as
    - famous
    - proud
    - influential
    - successful
    - talented
Gary breaks the world record for most controversial tweet.

As a result, PersonX feels
- proud
- happy
- excited
- satisfied
- accomplished

As a result, PersonX wants
- to celebrate
- to tell others
- to tell everyone
- to tell everyone about it
- to tell everyone about the event

PersonX then
- gets ridiculed
- becomes famous
- is praised
- none
- gets a medal
Gary breaks the world record for most controversial tweet.

As a result, others feel
- interested
- shocked
- surprised
- sad

As a result, others want
- to hear about it
- to listen to person x
- to listen
- to hear about the event

Others then
- people watch person x
- people listen to person x
- people listen to person x
- people listen
Dave buys a suit jacket in Seoul while on a business trip.
Dave buys a suit jacket in Seoul while on a business trip.
Dave buys a suit jacket in Seoul while on a business trip.
Concluding Remarks
Can we ever move from recognition to cognition?
Might be impossible to model cognitive visual understanding without complex & rich language

Knowledge modeling (or commonsense modeling) has to be a thing

Can we ever move from recognition to cognition?

Extremely unlikely that the current recipe of lots of (input, output) training data will generalize well
Revisiting Commonsense

I was told not to speak the word commonsense...

Past failures (in 70s – 80s) are inconclusive
  -- weak computing power
  -- not much data
  -- no crowdsourcing
  -- not as strong computational models
  -- not ideal conceptualization / representations
focus on “causes and effects” (causal knowledge)

ATOMIC

tinyurl.com/atomic-

(semi-) supervised learning of declarative knowledge

NEURAL

(generalizes well to compositional & unseen events)

self supervised learning of observed knowledge

COMeT

SYMBOLIC

but in LANGUAGE (instead of LOGIC)

Language Models
Thanks!