Commonsense resources
Grandma’s glasses

Tom’s grandma was reading a new book, when she dropped her glasses.

She couldn’t pick them up, so she called Tom for help.

Tom rushed to help her look for them, they heard a loud crack.

They realized that Tom broke her glasses by stepping on them.

Promptly, his grandma yelled at Tom to go get her a new pair.
Humans reason about the world with mental models [Graesser, 1994]
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**Personal experiences** [Conway et al., 2000]
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- Personal experiences [Conway et al., 2000]
- World knowledge and commonsense [Kintsch, 1988]
Humans reason about the world with **mental models** [Graesser, 1994]

Personal experiences [Conway et al., 2000]

World knowledge and commonsense [Kintsch, 1988]

**Commonsense resources** aim to be a bank of knowledge for machines to be able to reason about the world in tasks.
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Overview of existing resources

*Cyc* (Lenat et al., 1984)
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- Cyc (Lenat et al., 1984)
- OpenCyc (Lenat, 2004)
- ResearchCyc (Lenat, 2006)
- OpenCyc 4.0 (Lenat, 2012)

today
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- **Open Mind Common Sense** (Minsky, Singh & Havasi, 1999)
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- **ATOMIC** (Sap et al., 2019)

*today*
How do you create a commonsense resource?
Desiderata for a good commonsense resource

<table>
<thead>
<tr>
<th>Coverage</th>
<th>Useful</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Large scale</td>
<td>• High quality knowledge</td>
</tr>
<tr>
<td>• Diverse knowledge types</td>
<td>• Usable in downstream tasks</td>
</tr>
</tbody>
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Desiderata for a good commonsense resource

**Coverage**
- Large scale
- Diverse knowledge types

**Useful**
- High quality knowledge
- Usable in downstream tasks

Multiple resources tackle different knowledge types
Creating a commonsense resource

Representation
- Symbolic
- Natural language

Knowledge type
- Domain-specific
- Semantic
- Inferential
CONCEPT NET:
semantic knowledge in natural language form

http://conceptnet.io/
en reading
An English term in ConceptNet 5.8
reading is a subevent of...

- you learn
- turning a page
- learning

reading
An English term in ConceptNet 5.8
Related terms

- book
- books
- book

reading is a subevent of...

- you learn
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**reading**
An English term in ConceptNet 5.8
Related terms:
- book →
- books →
- book →

Effects of reading:
- learning →
- ideas →
- a headache →

reading is a subevent of...
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reading is a type of...

- an activity
- a good way to learn
- one way of learning
- one way to learn
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Related terms
- book
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reading is a subevent of...
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reading is a type of...
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Types of reading
- browse
- bumf
- clock time
- miles per hour
What is ConceptNet?

• General commonsense knowledge
• 21 million edges and over 8 million nodes (as of 2017)
  • Over 85 languages
  • In English: over 1.5 million nodes
• Knowledge covered:
  • Open Mind Commonsense assertions
  • Wikipedia/Wiktionary semantic knowledge
  • WordNet, Cyc ontological knowledge

http://conceptnet.io/
ATOMIC:

inferential knowledge in natural language form

https://mosaickg.apps.allenai.org/kg_atomic
**ATOMIC**: 880,000 triples for AI systems to reason about *causes* and *effects* of everyday situations
X repels Y's attack. Nine inference dimensions:

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

As a result, Y feels weak and ashamed. Y wants to run home and attack X again. Y gets hurt. Y falls back. X gains an enemy. X's heart races. X feels tired. X feels angry. X wants to leave the scene. X wants to file a police report.
Causes

X repels Y's attack

because X wanted to
before, X needed to

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

X is skilled
X is brave
X is strong

does X feel?

Y feels weak
Y feels ashamed
Y wants to run home

does Y want?

Y wants to attack X again

as a result, X feels
as a result, Y feels
as a result, Y wants

X feels angry
X feels tired
X's heart races
X gains an enemy

Y falls back
Y gets hurt
X repels Y’s attack

Effects:
- X wants to file a police report
- X wants to leave the scene
- X feels angry
- X feels tired
- X’s heart races
- X gains an enemy
- Y feels weak
- Y feels ashamed
- Y wants to run home
- Y gets hurt
- X is skilled
- X is brave
- X is strong
- X is trained
- X needed to train hard
- X wanted to protect others
- X wanted to save themselves
Dynamic

X repels Y’s attack

- X wanted to train hard
- X needs to know self-defense
- X is skilled
- X is brave
- X is strong

before, X wanted to
because X wanted to

X wanted to protect others
X wanted to save themselves

as a result, X feels
- X feels angry
- X feels tired
- X’s heart races

as a result, Y feels
- Y feels weak
- Y feels ashamed

as a result, Y wants
- Y wants to run home
- Y wants to attack X again

has an effect on X
- X gains an enemy
- X gains an effect on X

has an effect on Y
- Y falls back
- Y gets hurt

as a result, Y wants
- Y wants to run home
- Y wants to attack X again

X is seen as

X is skilled
X is brave
X is strong
X repels Y's attack

because X wanted to
before, X needed to

as a result, X feels

as a result, Y feels

as a result, Y wants

X feels angry
X feels tired
X's heart races
X gains an enemy
X needs to train hard
X needs to know self-defense
X is skilled
X is brave
X is strong

X feels weak
X feels ashamed
Y wants to run home
Y wants to attack X again
Y gets hurt
Y falls back
Voluntary

X repels Y's attack

Because X wanted to save themselves, X needed to train hard and know self-defense.

X is seen as skilled and brave.

As a result, Y feels weak and ashamed, Y wants to run home and attack X again.

X feels angry and tired, X's heart races.

X gains an enemy, Y falls back and gets hurt.

X wants to leave the scene, X wants to file a police report.
Involuntary

X repels Y's attack

because X wanted to
before, X needed to

as a result, X feels

as a result, Y feels

has an effect on X
has an effect on Y

as a result, Y wants

Y feels weak
Y feels ashamed
Y wants to run home

X is skilled
X is brave
X is strong

X wanted to protect others
X wanted to save themselves
X wanted to file a police report
X wants to leave the scene

X feels angry
X feels tired
X's heart races
X gains an enemy
Y falls back
Y gets hurt

Y wants to attack X again

Involuntary
Agent X repels Y's attack

because X wanted to

before, X needed to

has an effect on X

as a result, Y feels

as a result, Y wants

has an effect on Y

as a result, Y falls back

as a result, Y gets hurt

has an effect on X

X feels angry

X feels tired

X gains an enemy

X's heart races

X wants to leave the scene

X wants to file a police report

X wanted to save themselves

X wanted to protect others

X needs to train hard

X needs to know self-defense

X is skilled

X is strong

X is brave

X feels weak

X feels ashamed

X wants to run home

X wants to attack X again
X repels Y's attack

X was wanted to protect others, hence X needed to train hard. X is seen as skilled, brave, and strong, because X wanted to save themselves. X has an effect on Y, as a result, Y feels weak and ashamed. As a result, Y wants to run home. Y wants to attack X again, as a result, Y gets hurt.
300,000 event nodes to date
880,000 if-Event-then-* knowledge triples
ATOMIC: knowledge of *cause* and *effect*

- Humans have **theory of mind**, allowing us to
  - make inferences about **people's mental states**
  - understand **likely events** that precede and follow (Moore, 2013)
Atomic: knowledge of cause and effect

• Humans have theory of mind, allowing us to
  • make inferences about people’s mental states
  • understand likely events that precede and follow (Moore, 2013)

• AI systems struggle with inferential reasoning
  • only find complex correlational patterns in data
  • limited to the domain they are trained on (Pearl; Davis and Marcus 2015; Lake et al. 2017; Marcus 2018)
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(today)
Existing knowledge bases

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  (Sap et al., 2019)

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Existing knowledge bases

Represented in **symbolic logic**
(e.g., LISP-style logic)

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  (Mitchell et al., 2015)
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Represented in **natural language**
(how humans *talk* and *think*)

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```prolog
(\$implies
  (\$and
    (\$isa \$OBJ \$SUBSET)
    (\$genls \$SUBSET \$SUPERSET))
  (\$isa \$OBJ \$SUPERSET))
```
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Knowledge of “**what**”
(taxonomic: A isA B)

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

- **ATOMIC**
  (Sap et al., 2019)
Q: How do you gather commonsense knowledge at scale?

A: It depends on the type of knowledge.
Extracting commonsense from text

Based on information extraction (IE) methods
1. Read and parse text
2. Create candidate rules
3. Filter rules based on quality metric

Advantage:
can extract knowledge automatically

Example system:
Never Ending Language Learner (NELL; Carlson et al., 2010)

... more on this later with temporal commonsense
Some commonsense cannot be extracted

Text is subject to **reporting bias** (Gordon & Van Durme, 2013)

- Idioms & figurative usage
  “Black sheep problem”

- Noteworthy events
  Murdering 4x more common than exhaling

Commonsense is not often written
-> *Grice’s maxim of quantity*

found when extracting commonsense knowledge on four large corpora using Knext (Gordon & Van Durme, 2013)
Eliciting commonsense from humans

Experts create knowledge base

• Advantages:
  • Quality guaranteed
  • Can use complex representations (e.g., CycL, LISP)

• Drawbacks:
  • Time cost
  • Training users

*OpenCyc 4.0* (Lenat, 2012)  *WordNet* (Miller et al., 1990)
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Non-experts write knowledge in natural language phrases

• Natural language
  • Accessible to non-experts
  • Different phrasings allow for more nuanced knowledge

• Fast and scalable collection
  • Crowdsourcing
  • Games with a purpose

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*OpenCyc 4.0 (Lenat, 2012)*

*WordNet (Miller et al., 1990)*

*ATOMIC (Sap et al., 2019)*

*ConceptNet 5.5 (Speer et al., 2017)*
Knowledge bases and mitigating biases

• Different data collection methods suffer from social biases differently
• ConceptNet word embeddings have less demographic biases than GloVe embeddings [Sweeney & Najafian, 2019]
Knowledge bases and mitigating biases

PersonX clutches a gun because X wanted to

ATOMIC (Sap et al., 2019)
Knowledge bases and mitigating biases

**PersonX clutches a gun** → because X wanted to

- to be safe
- to protect himself
- to protect themselves
- to defend themselves
- to defend himself

**Jaquain clutches a gun** → because X wanted to

- to kill someone
- none
- to protect himself
- to be safe
- to protect themselves

**Karen clutches a gun** → because X wanted to

- to be safe
- to protect himself
- to shoot
- to get the gun
- none

COMET (Bosselut et al., 2019): ATOMIC + OpenAI GPT
What’s next with commonsense resources?

• Use them with models in downstream tasks
  • Reading comprehension, QA tasks, etc.

• Create inference or reasoning engines
  • Knowledge base construction, multi-hop reasoning, etc.
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She couldn’t pick them up, so she called Tom for help.

They realized that Tom broke her glasses by stepping on them.

Promptly, his grandma yelled at Tom to go get her a new pair.

Thanks! Questions?