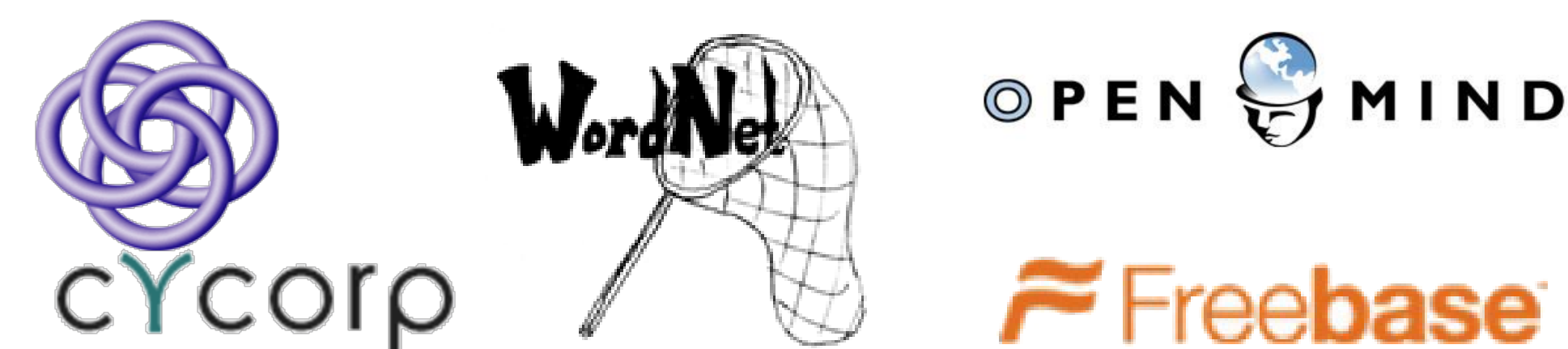


Types of Common-Sense Knowledge Needed for Recognizing Textual Entailment

Knowledge about how the world works, or common-sense knowledge, is vital for Natural Language Understanding.



What other kinds of knowledge might lie outside the collections that the community has focused on building?

Methodology

We manually selected 108 out of 600 RTE-5 pairs data that needed world knowledge **other than linguistic knowledge, coreference decisions, synonymy, or hypernymy** to define them as ENTAILMENT or CONTRADICTION.

For each of these 108 pairs, we created **proofs**, or a step-by-step sketch of the inferences that lead to a decision about entailment of the hypothesis.

Each line in the proof either:

includes a new piece of background knowledge brought to bear

or

is a modus ponens inference from the information in the text or previous lines of the proof

This resulted in **221 diverse statements** of world knowledge that we then grouped into **20 distinct categories**.

Examples of RTE Proofs

#302 - CONTRADICTION

T: Barack Obama is due to end his first overseas trip as US President today. Mr Obama has attended [...] a conference of EU leaders in Prague. [...]

- 1) "President" is part of government.....
- 2) "EU" is a government body.....
- 3) "US" and "EU" are exclusive government bodies.....
- 4) A person is a leader in only one exclusive government body.....

H: Barack Obama is an EU leader.

#460 - ENTAILMENT

T: India is seeking extradition, but the fact that Nepalese authorities have added their own charges of illegal organ transplants in on top of the foreign currency possession charges, could delay proceedings. [...]

- "Nepalese authorities have added their own charges on top of the foreign currency possession charges"
- 1) "Nepal" is a country.....
 - 2) Countries have laws.....
 - 3) laws exist where charges exist.....
 - "Nepal" has laws
 - 4) "Nepalese authorities" represent Nepal.....
 - 5) A country is in control of its charges.....

H: Nepal has laws about foreign currency.

#401 - ENTAILMENT

T: [...] A train operated by Robert Morgan, 64, passed a red signal at Purley and struck an oncoming service on March 4, 1989, killing five and injuring 80 more. [...]

- "A train operated by Robert Morgan"
- 1) "Robert Morgan" is responsible for the "train".....
 - "A train passed a red signal [...], killing five"
 - 2) "the train" is responsible for "killing five".....
 - 3) "Robert Morgan" killed "five".....

H: Robert Morgan killed 5 people.

Knowledge Types

is member of

Statements of this category indicate that an entity belongs to a larger organization.

Definition

Any explanation of a word or phrase.

Mutual Exclusivity

Related to functionality, mutual exclusivity knowledge indicates types of things that do not participate in the same relationship.

Functionality

This category lists relationships R which are functional; i.e., $\exists x,y,y \ 0R(x, y) \wedge R(x, y0) \Rightarrow y = y0$.

Geography

This includes knowledge such as "Australia is a place," "Sydney is in Australia," and "Canberra is the capital of Australia."

has parts

This category expresses what components an object or situation is comprised of.

Simultaneous Condition

Knowledge in this category indicates that a predicate p must hold true at the same time as an event or second predicate p0.

Synecdoche

Synecdoche is knowledge that a person or thing can represent or speak for an organization or structure he or she is a part of.

Accountability

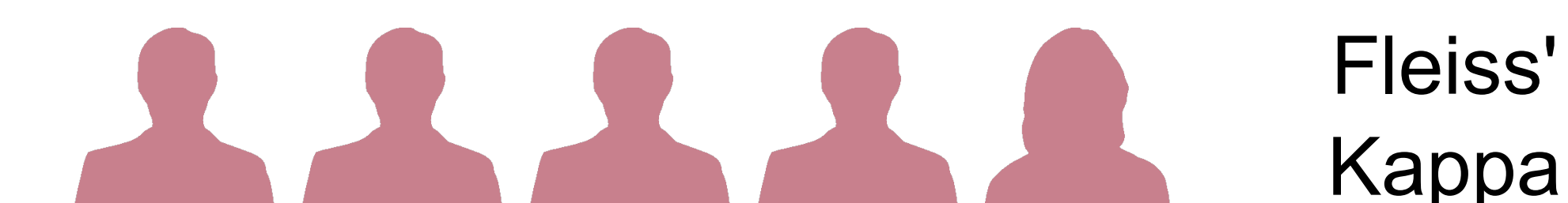
This includes any knowledge that is helpful for determining who or what is responsible for an action or event.

Transitivity

If we know that R is transitive, and that R(a, b) and R(b, c) are true, we can infer that R(a, c) is true.

Frequencies and Inter-Annotator Agreement

Five annotators individually categorized the statements of world knowledge.



Category	Frequencies	κ
Form-based Categories		
Functionality	8.7%	0.663
Definitions	7.8%	0.633
Preconditions	7.1%	0.775
Cause and Effect	4.9%	0.591
Prominent Relationship	3.8%	0.145
Argument Types	3.1%	0.180
Simultaneous Conditions	2.8%	0.203
Mutual Exclusivity	2.7%	0.640
Transitivity	1.4%	0.459
Content-based Categories		
Geography	16.5%	0.927
Support/Opposition	6.6%	0.684
Arithmetic	6.1%	0.968
in member of	5.2%	0.663
Synecdoche	4.4%	0.829
has parts	4.0%	0.882
Accountability	3.3%	0.799
Cultural/Situational	2.1%	0.267
Public Entities	1.4%	0.429
Miscellaneous Categories		
Omniscience	3.3%	0.828
Probabilistic Dependency	2.2%	0.297
All	97%	0.678

A Fleiss's κ score of 0.678 indicates that our categories are **overall well-defined**. Concentrating on collecting these kinds of world knowledge will make a large difference to RTE, and hopefully to language understanding in general.