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Exploring and Analyzing Machine Commonsense Benchmarks

Henrique Santos, Minor Gordon, Zhicheng Liang, Gretchen Forbush, Deborah L. McGuinness

February 8th 2021

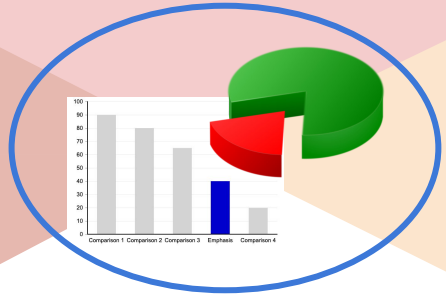
Commonsense Knowledge Graphs Workshop @AAAI-21

Task creators

- What are the dimensions currently not being sufficiently evaluated, potentially indicating the need of new tasks?
- What metadata is relevant to include in my task?

PIs, PMs, grad students

- What dimensions is a benchmark (or a benchmark subset) evaluating?



System developers

- How can I assess my system/model with regards to evaluation dimensions? In what it is doing well or poorly?
- What datasets can I use to train my system in specific dimensions

The Machine Common Sense Ecosystem

How to support insights into tasks?

- A common vocabulary for data and metadata about elements of the MCS ecosystem
- Data model based on dimensions
- Focus on what is already publicly available - a *living literature review*
- Display as a unified dashboard with browsing capabilities

Evaluation dimensions

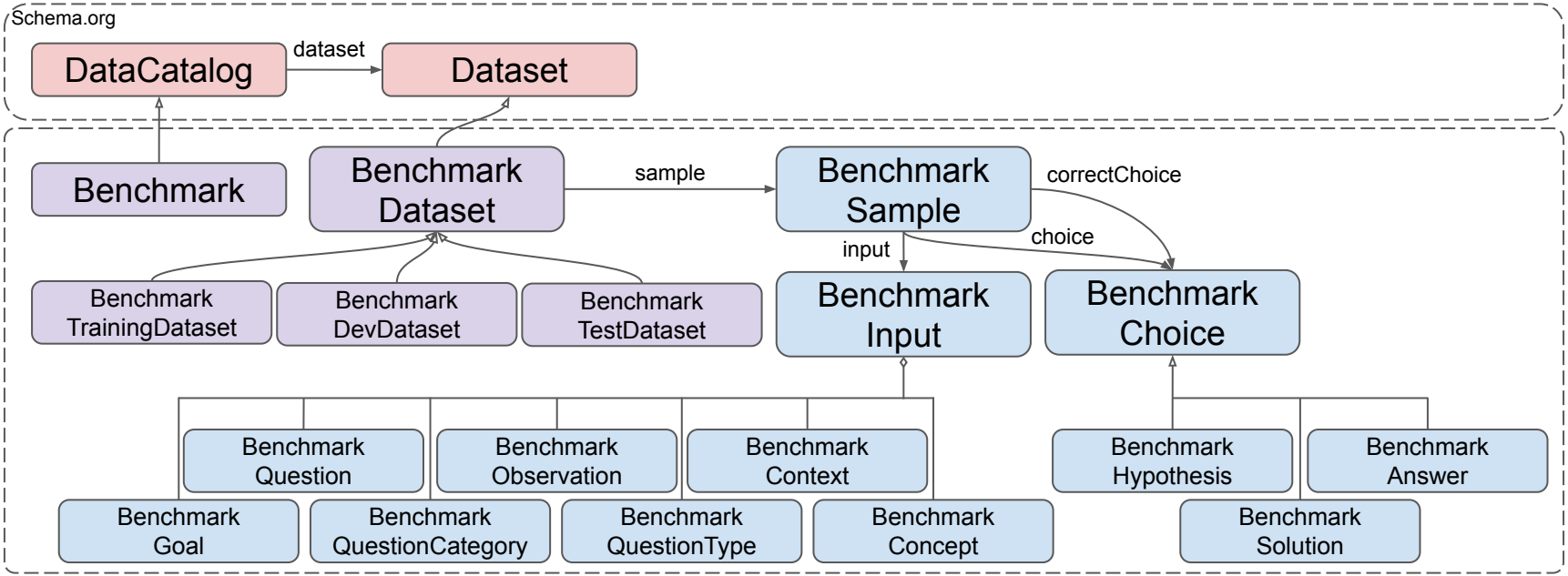
Dimension	Year-1
question type	multiple-choice
topic	various (social, physical, events)
reasoning type	mixed
training data size	full, or slightly reduced
interpretability	black-box, paths
inference level	mixed
model universality	different models

* from USC/ISI slides - September 2020 DARPA meeting (with modifications)

DARPA MCS Year 1 Benchmarks

Benchmark	Constructs	Choice type
aNLI	- Observations - Hypothesis	- Multiple choice
CommonsenseQA	- Questions - Answer choices	- Multiple choice
Cosmos QA	- Context - Questions - Answer choices	- Multiple choice
CycIC	- Questions - Answer choices - Fill in the blank - Categories	- Multiple choice - True/false
HellaSwag	- Context - Ending choices	- Multiple choice
Physical IQa	- Goals - Solution choices	- Multiple choice
Social IQa	- Context - Questions - Answer choices	- Multiple choice

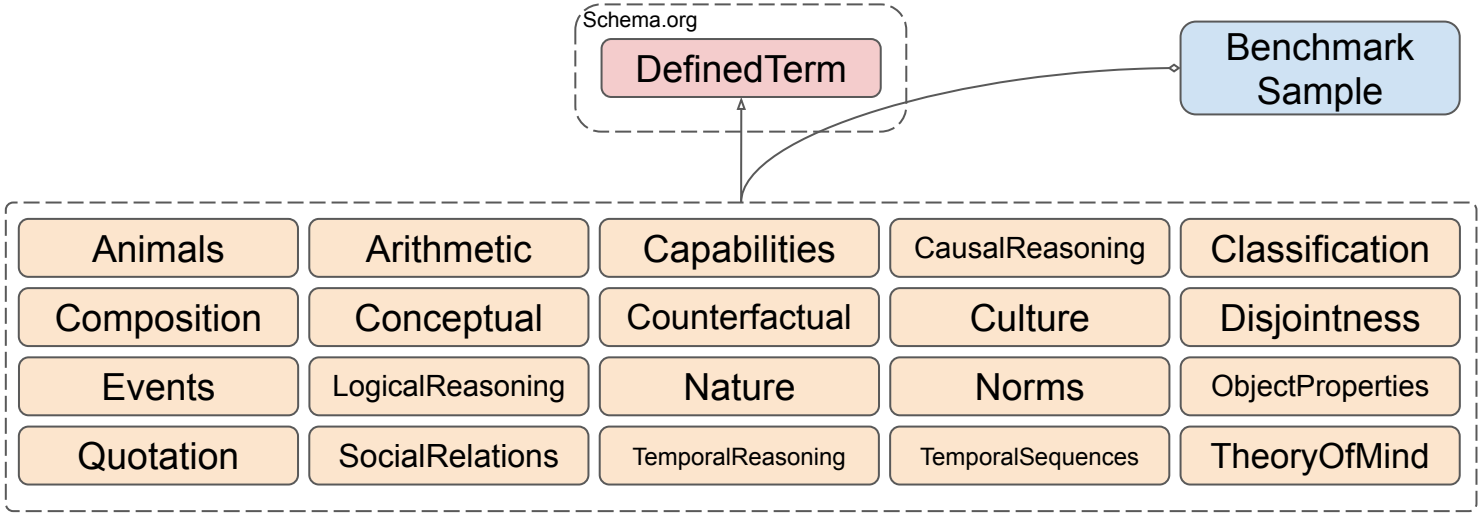
Machine Commonsense Benchmark Ontology



https://github.com/tetherless-world/mcs-ontology

Machine Commonsense Benchmark Ontology

Benchmark categorization



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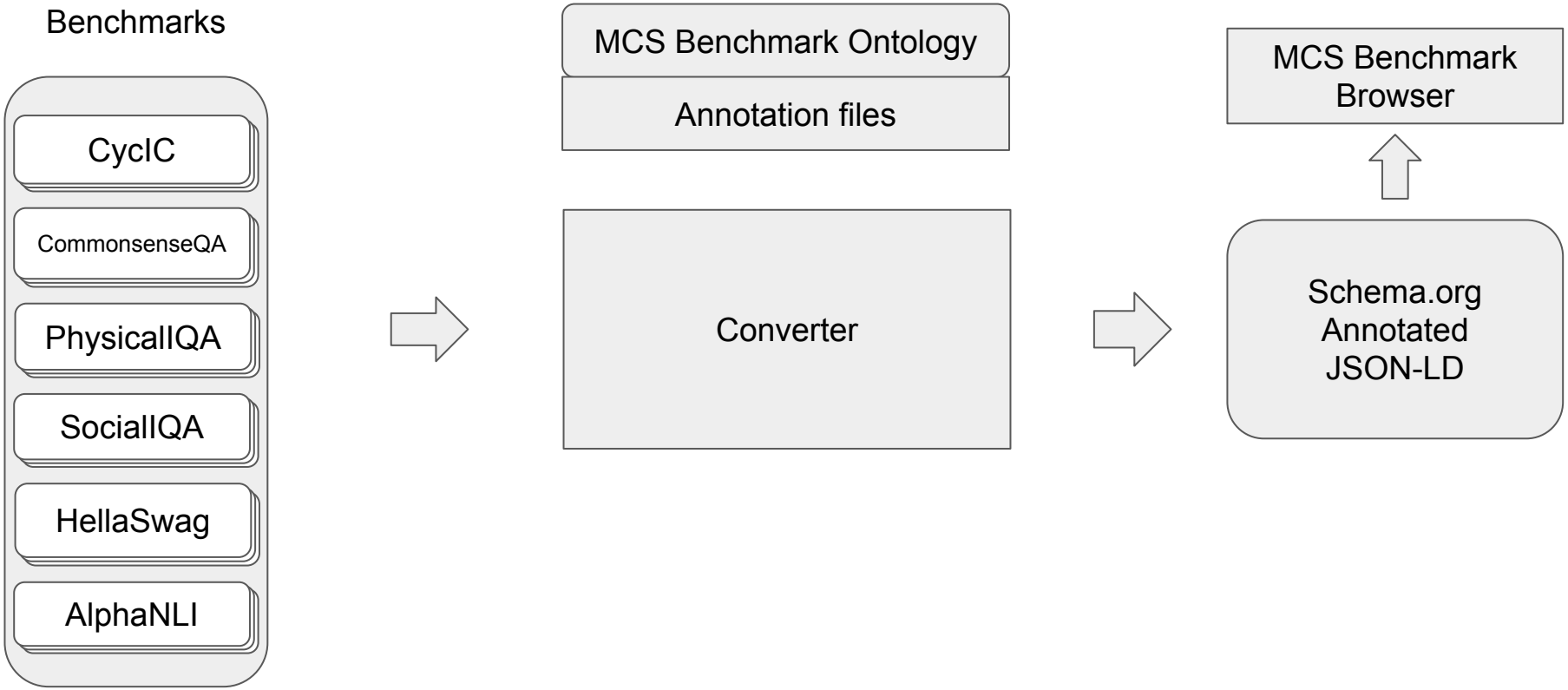
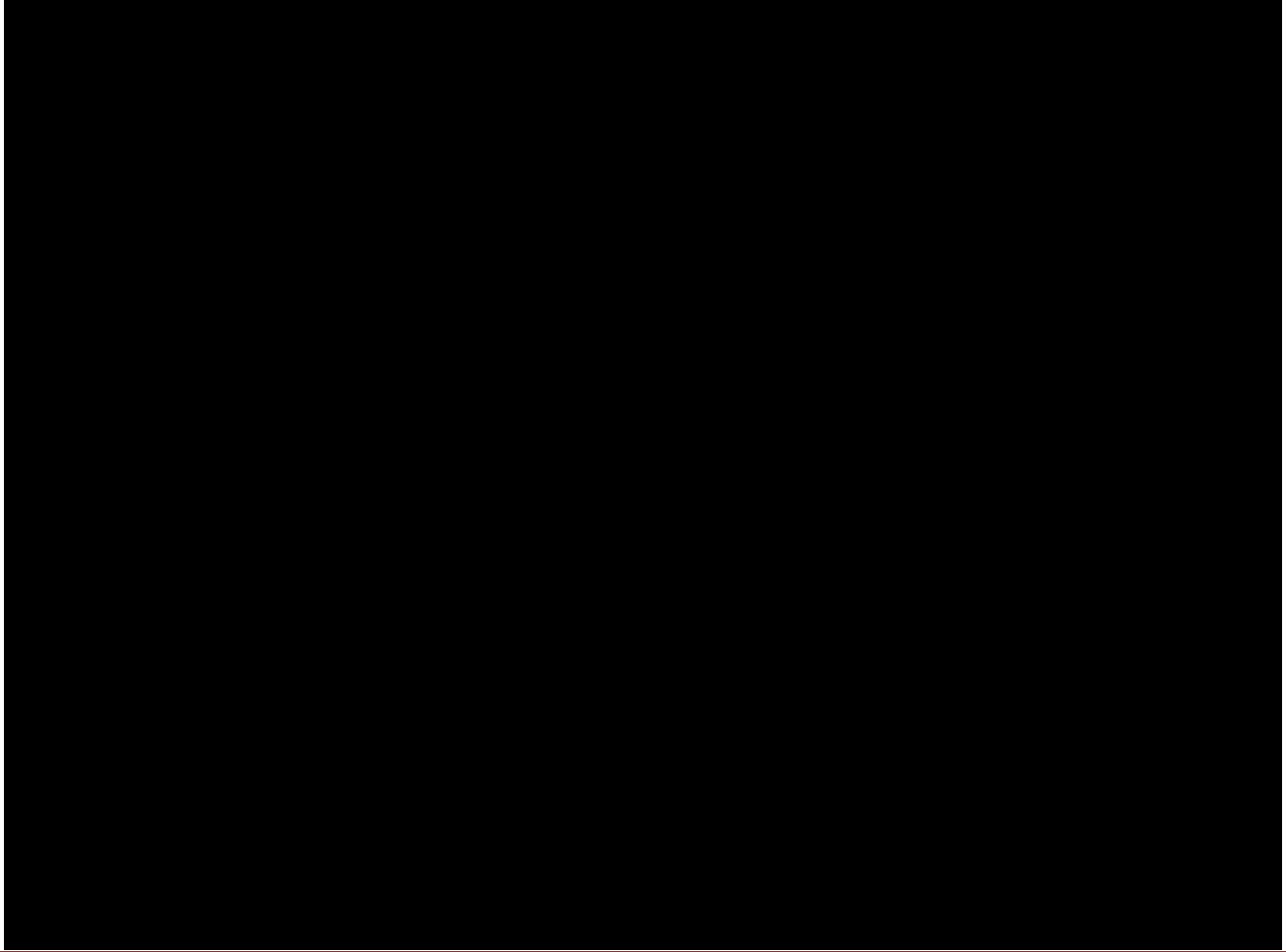

Benchmarks
CycIC
CommonsenseQA
PhysicalIQA
SocialIQA
HellaSwag
AlphaNLI
MCS Benchmark Ontology
Annotation files
Converter
MCS Benchmark Browser
Schema.org Annotated JSON-LD



Next steps

- Incorporation of open-ended benchmarks
- Refinement and deeper representation of commonsense theories
  - Currently researching commonsense principles (or theories - Time, Space, Causality ...) to further characterize tasks

Takeaways

- Benchmark metadata is crucial to allow precise description of tasks
- There is a lack of consensus of what would this metadata be

Our vision

A formalized metadata layer for machine common sense that can comprehensively describe tasks/benchmarks in terms of commonsense psychology and its theories, and capable of effectively characterizing the human thinking process.

Questions?

Exploring and Analyzing Machine Commonsense Benchmarks

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- What metadata is relevant to include in my task?

PIs, PMs, grad students

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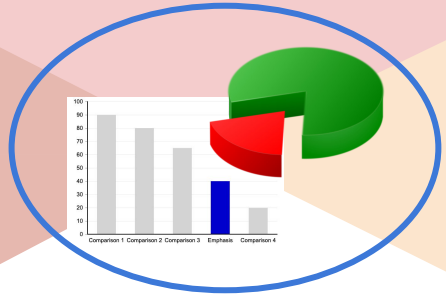
- What questions (or question types) are used to challenge systems in a specific dimension (e.g. temporal reasoning)



System developers

- How can I assess my system/model with regards to evaluation dimensions? In what it is doing well or poorly?
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- What datasets can I use to train my system in specific dimensions

The Machine Common Sense Ecosystem

What is currently possible

- Integration of multi-choice benchmarks
- Categorization of benchmarks and samples (questions) in standardized terms
- Browsing and visualization of benchmarks contents

```
{
 "@context": "https://tetherless-world.github.io/mcs-ontology/utils/context.jsonld",
 "@id": "SocialIQA-[line_number]",
 "@type": "BenchmarkSample",
 "includedInDataset": "SocialIQA/train",
 "input": [
   {
     "@type": "BenchmarkContext",
     "name": "Context",
     "text": "Aubrey offered tribute to the gods. They did this out of reverence.",
     "position": 0
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   {
     "@type": "BenchmarkQuestion",
     "name": "Question",
     "text": "How would Others feel as a result?",
     "position": 1
   }
 ],
 "choice": [
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     "text": "they were different",
     "position": 1
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   {
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     "text": "religious and spiritual",
     "position": 2
   },
   {
     "@type": "BenchmarkAnswer",
     "text": "they were unique",
     "position": 3
   }
 ],
 "correctChoice": 3
}
```


Example question in the JSON-LD format

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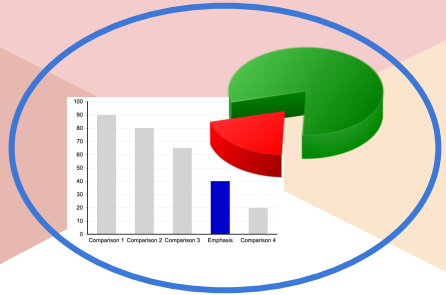

MCS Ecosystem

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Selected Motivating Questions

- Can we understand weaknesses of QA systems by analyzing failed cases?
- Is it possible to classify diverse commonsense benchmark samples - questions - in common categories following an agreed criteria?
- How can tools provide stakeholders with insights into the current state-of-the-art of commonsense ecosystems and their sub-tasks?

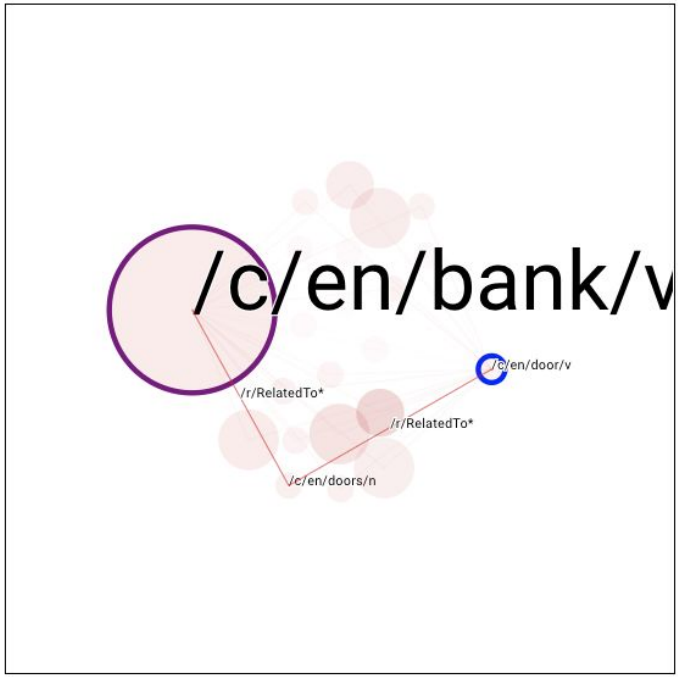
Benchmarks

- Composed by training, development, and test datasets
- Test datasets are usually not available for systems' developers
- May have specific thematics (e.g. social interactions, "how-to's")
  - Or just be general purpose
- They vary in structure
  - Question-answers
  - Observation-hypothesis
  - Goals-solutions
  - …
- They provide different levels of information a system can use
  - Question type, required type of reasoning, source concept ...

kagnet submission answer choice analyses

Answer Paths for **bank** More edges Fewer edges High score Low score

Score: 0.818 20 paths



Start node: /c/en/door/v End node: /c/en/bank/v

Score	Number of nodes	Path
0.07347899675369263	3	/c/en/door/v /r/RelatedTo* /c/en/doors/n /r/RelatedTo* /c/en/bank/v
0.0719200000166893	3	/c/en/door/v /r/RelatedTo /c/en/houses/v /r/RelatedTo* /c/en/bank/v
0.07078800350427628	3	/c/en/door/v /r/RelatedTo /c/en/home/v /r/RelatedTo* /c/en/bank/v
0.06894899904727936	3	/c/en/door/v /r/RelatedTo /c/en/getting/v /r/RelatedTo* /c/en/bank/v
0.06700500100851059	3	/c/en/door/v /r/RelatedTo* /c/en/time_lock/n /r/RelatedTo /c/en/bank/v

DARPA's vision

- Machine common sense as a computational service
- ...that learns from experience, like a child
- ...that learns from reading the Web, like a research librarian

Supporting DARPA's vision

- Ability to actively expose the commonsense service (or pool of services) to diverse tasks, including new and specialized tasks
  - To learn, to probe
- Ability to score systems across benchmarks, not only by task
- Ability to analyze systems' at sample level (question level), not only by the overall score
- Ability to selectively probe systems with specific types of samples (questions, observations, etc.)