Reasoning Technologies at SRI

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Vision and Learning,

Center for Vision Technologies

Capability Summary

- Key relevant capabilities
  - Causal discovery and inference
  - Comprehension using large language models
  - Multi-modal data analytics
- Key relevant government programs
  - DARPA KMASS, AFRL MESA, ONR CEROSS, DARPA CCU, DARPA Civil Sanctuary, DARPA MIPS
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Causal Discovery Aided Tabular Data Analytics

- Discover causal relationships in the data to exclude the influence of spurious correlations on successive analysis
- Employ hierarchical transformers to process dynamic tabular data including both categorical and continuous inputs for a wide range of tasks, e.g., prediction, classification, etc.
- Leverage transformer's generative capability, in conjunction with discovered causal diagrams, to perform counterfactual analysis
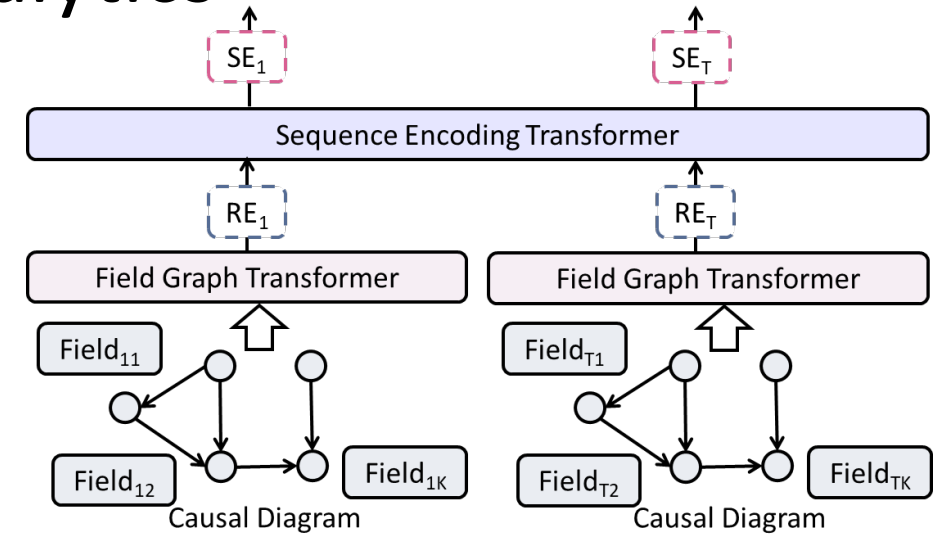

Causal Discovery on Migration Dataset
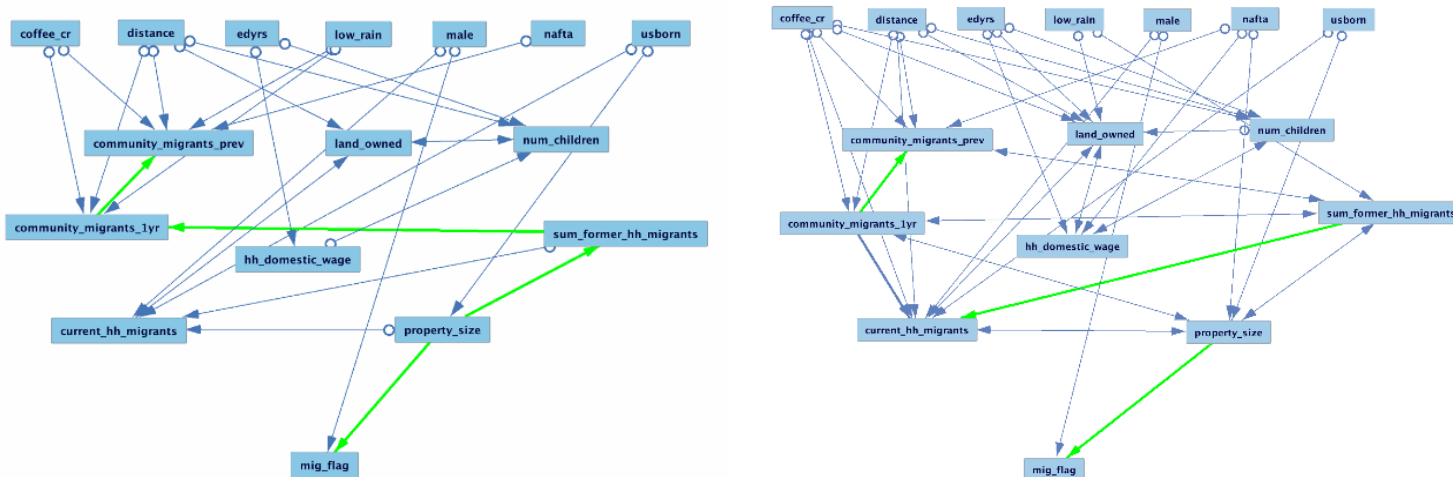
Causal Discovery on Covid19 Dataset

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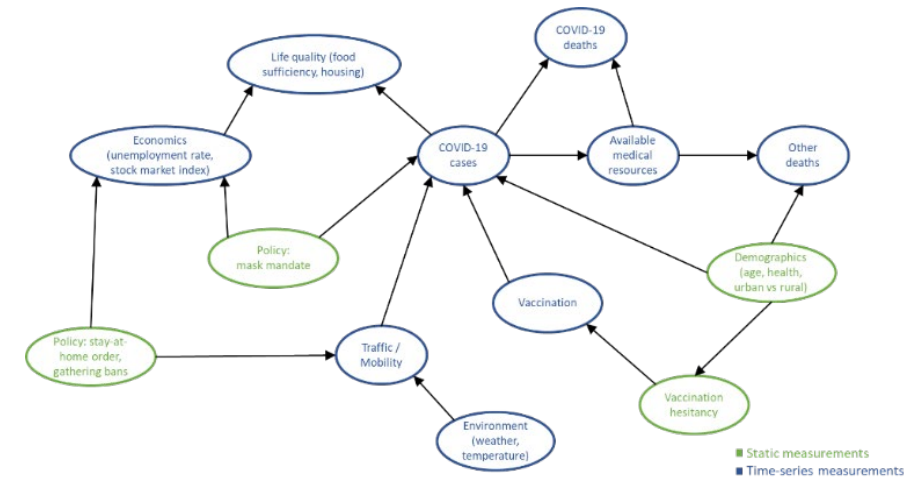
Comprehension Using Large Language Models

- **Motivation**: Bloom's taxonomy as a science grounded graded approach to learning and accessing comprehension
- **Approaches**: 1) Defined comprehension using Bloom's Taxonomy; 2) Operationalized Bloom's Taxonomy via proximal context, the proximal context for Level n comes from Level n-1; 3) use proximal context to generate prompts and improve QA
- **Advantages**: Task agnostic, No additional learning
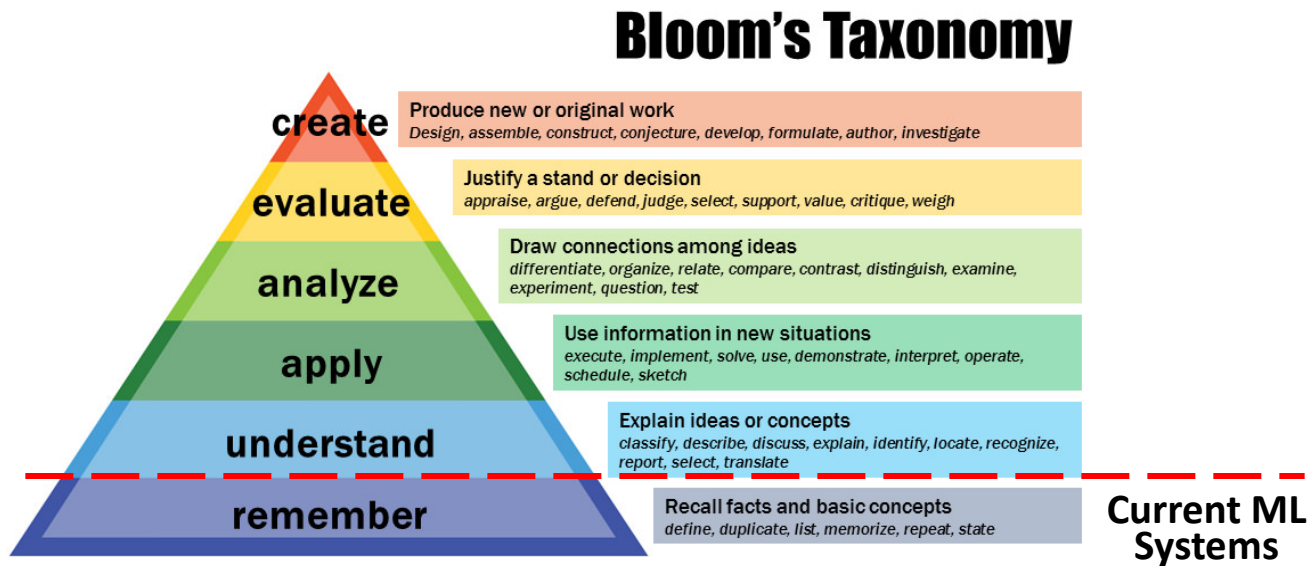
Task	Model	Level	Accuracy
Winogrande (1267 total) (2: Understand)	Distil-GPT2 (235±5 valid)	0A: Choice Baseline	53.2 ± 1.8
		1A: Remember*	**54.7 ± 3.6**
		2A: Understand	52.5 ± 3.1
	GPT-Neo (1230±7 valid)	0A: Choice Baseline	54.62 ± 0.5
		1A: Remember*	**54.77 ± 0.5**
		2A: Understand	54.76 ± 0.3
SocialIQA (1954 total) (3: Apply)	Distil-GPT2 (58±5 valid)	0B: Choice Baseline	44.5 ± 0.1
		1B: Remember	43.7 ± 2.1
		2B: Understand*	**48.0 ± 1.1**
		3B: Apply	44.4 ± 1.8
	GPT-Neo (1334±9 valid)	0B: Choice Baseline	**48.74 ± 0.4**
		1B: Remember	47.31 ± 0.1
		2B: Understand*	**48.44 ± 0.5**
		3B: Apply	48.1 ± 0.1
COPA (100 total) (3: Apply)	Distil-GPT2 (11±2 valid)	0C: Choice Baseline	**54.9 ± 0.9**
		1C: Remember	46.0 ± 14.7
		2C: Understand*	**53.1 ± 12.5**
		3C: Apply	40.8 ± 15.2
	GPT-Neo (96±0 valid)	0C: Choice Baseline	**70.83 ± 0.0**
		1C: Remember	65.62 ± 0.0
		2C: Understand*	**70.83 ± 1.4**
		3C: Apply	**70.83 ± 0.0**
CommonsenseQA (1221 total) (3: Apply)	Distil-GPT2 (68±1 valid)	0D: Choice Baseline	**29.9 ± 2.7**
		1D: Remember	26.5 ± 3.3
		2D: Understand*	**28.1 ± 1.2**
		3D: Apply	25.6 ± 3.4
	GPT-Neo (1118±4 valid)	0D: Choice Baseline	40.59 ± 3.6
		1D: Remember	38.00 ± 6.0
		2D: Understand*	**43.19 ± 0.2**
		3D: Apply	42.30 ± 0.8

M. Cogswell, et al., Comprehension Based Question Answering using Bloom's Taxonomy, https://arxiv.org/pdf/2106.04653.pdf

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Multi-Modal Data Analytics

- **Multimodal Question Answering**
  - DARPA KMASS

- **Multimodal Social Media Analytics**
  - DARPA MIPS (Influence Pathways), DARPA Civil Sanctuary (Content Moderation and Mediation)
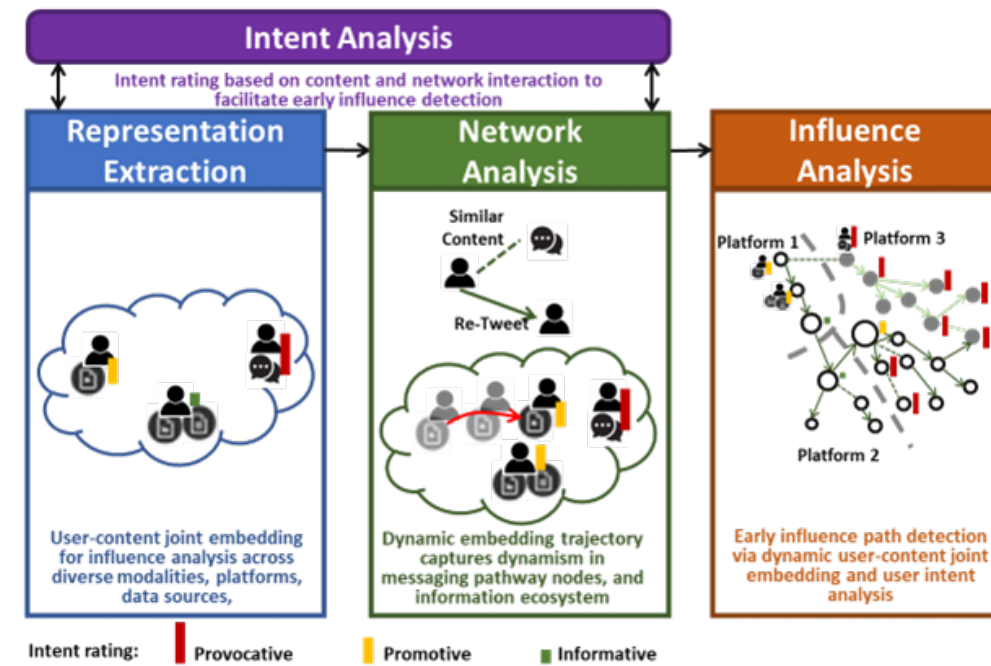
Hierarchical Transformer-based Reasoning System

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