



Causal AI for web and healthcare

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#causality, #causalAI, #CausalKG, #explainability, #web, #healthcare



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Tutorial Highlights

Why statistical AI alone is not enough

Causal AI and causal knowledge graph as a step towards neuro-symbolic AI?

Can ontologies be used as inference for causal explanations?

Can causal AI enable intervention planning and policy decisions making?

Can causal inference serve as a bridge between prediction and decision making?

Causal models as solution to traditional ML for generalizing new domains?

Table of Content

- A primer to causality
- CausalKG: Causal knowledge graph
- Ontology and knowledge based inferences for causal explanations
- Application of causal AI in web and healthcare use cases

Causal Primer: Ladder of Causation

Future Hybrid AI



Current AI Approach

Association based on the observational data

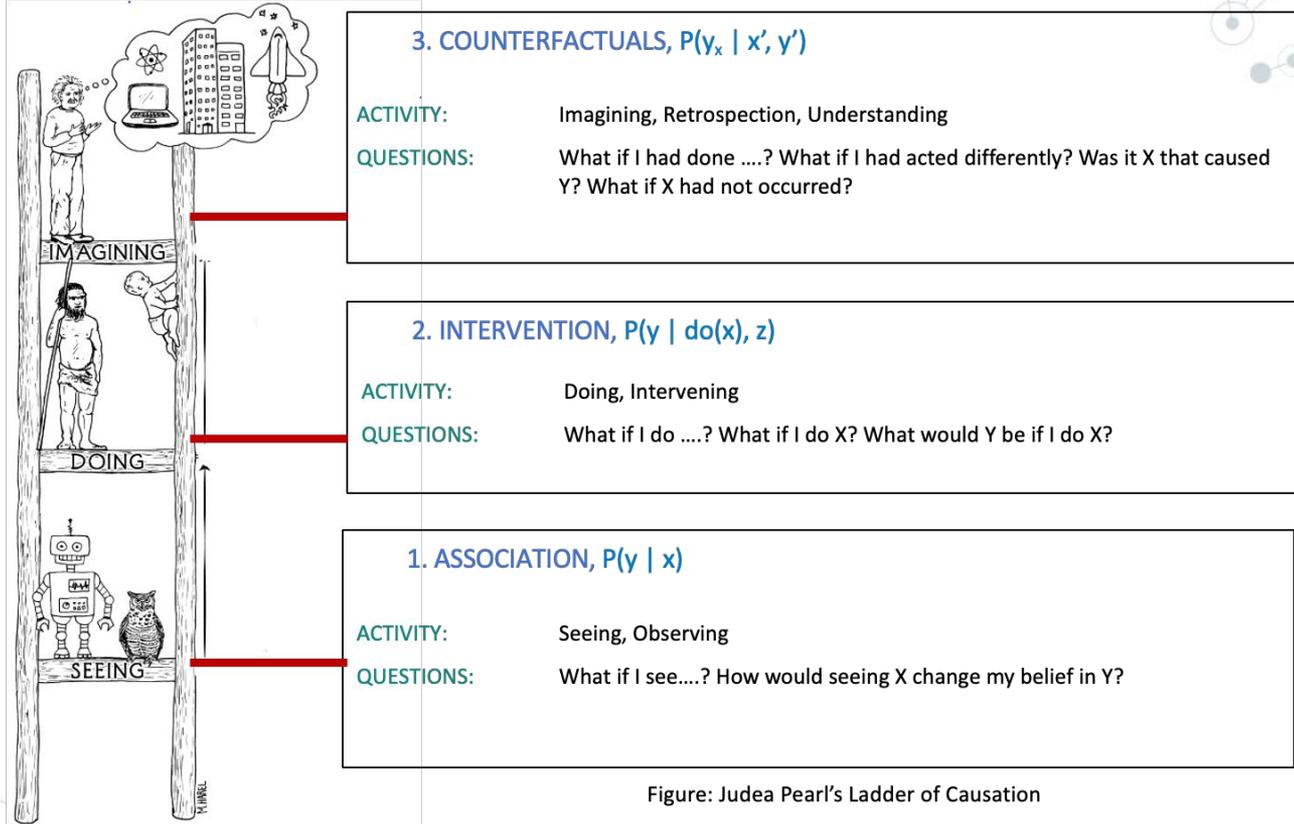


Figure: Judea Pearl's Ladder of Causation

Statistical Explainability

Context Explainability

Domain Explainability

Ladder of Causation

Rung 1: Seeing



Observational
data

Rung 2: Doing



Intervention

Rung 3: Imagining



Retrospection,
Understanding

Associational reasoning

- How would seeing X change my belief in Y?

Interventional reasoning

- For a given context,
What would Y be if I do X?

Counterfactual reasoning

- Was it X that caused y?

Data Representation

Causal Representation using KG

Current AI Approach

Future Hybrid AI Approach



Ontology and Knowledge based inference for Causal Explanation

I am a 35-year-old **F** who had open-heart surgery to replace an aortic valve. Diagnosed with UTI when **pregnant**. I experienced severe **fatigue** and **trembling** for two years stressing about it. I have **flashbacks** about certain events in the hospital that is affecting me now.

Reddit Post/Comment

I am a 35-year-old **<Woman>** who had open-heart surgery to replace an aortic valve. Diagnosed with UTI when **<Woman>**. I experienced severe **<Anxiety>** and **<Anxiety>** for two years stressing about it. I have **<PTSD>** about certain events in the hospital that is affecting me now.

Knowledge Aware Entity Masking

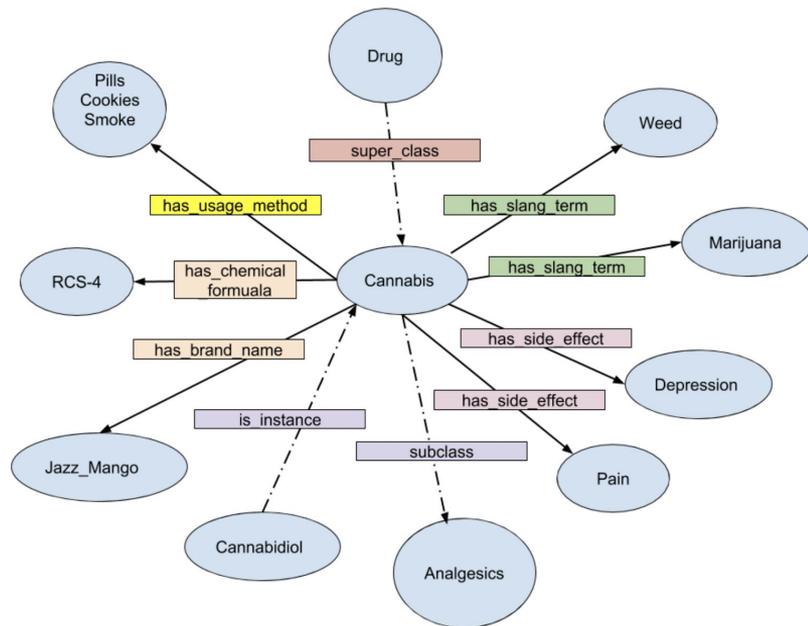
The screenshot shows an ontology viewer interface. The top navigation bar includes 'Active ontology', 'Entities', 'Individuals by class', 'Individual Hierarchy Tab', and 'DL'. Below this are tabs for 'Data properties', 'Annotation properties', 'Datatypes', and 'Individuals'. The main content area is titled 'Class hierarchy: Fatigue' and shows a tree structure of classes. The 'Mental_Disorders' class is expanded, showing sub-classes like 'Anxiety_Disorders', 'Bipolar_Disorders', 'Depressive_Disorders', etc. The 'Anxiety_Disorders' class is further expanded, showing sub-classes like 'Anxiety_Symptoms', 'Anxious', 'Fearful', 'Generalized_Anxiety_Disorder', 'Panic_Disorder', 'Separation_Anxiety_Disorder', 'Social_Anxiety_Disorder', and 'Specific_Phobia'. The 'Fatigue' class is highlighted in blue. On the right side, there is a 'Description: Fatigue' panel with various properties and relationships.

TASK: Explain Gender and Mental Health Prediction?

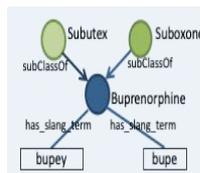
(Q): How is the Post expressing depression, anxiety or PTSD, if so Can we find the gender language?

(A): Concepts fatigue, trembling relate to Anxiety. Concepts 'F' and Pregnant relates to Woman.

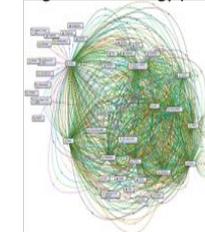
Ontology and Knowledge based annotations for Complex Causal Extraction



Entity Identification



Drug Abuse Ontology (DAO)



83 Classes
37 Properties

33:1 Buprenorphine
24:1 Loperamide

Sentiment Extraction

+ve	feel pretty damn good feel great
-ve	experience sucked didn't do shit bad headache

I was sent home with 5 x 2 mg Suboxones. I also got a bunch of phenobarbital (I took all 180 mg and it didn't do shit except make me a walking zombie for 2 days). I waited 24 hours after my last 2 mg dose of Suboxone and tried injecting 4 mg of the bupe. It gave me a bad headache, for hours, and I almost vomited. I could feel the bupe working but overall the experience sucked.

Of course, junkie that I am, I decided to repeat the experiment. Today, after waiting 48 hours after my last bunk 4 mg injection, I injected 2 mg. There wasn't really any rush to speak of, but after 5 minutes I started to feel pretty damn good. So I injected another 1 mg. That was about half an hour ago. I feel great now.

DIVERSE DATA TYPES

ENTITIES	
DOSAGE	PRONOUN
INTERVAL	Route of Admin.
RELATIONSHIPS	SENTIMENTS

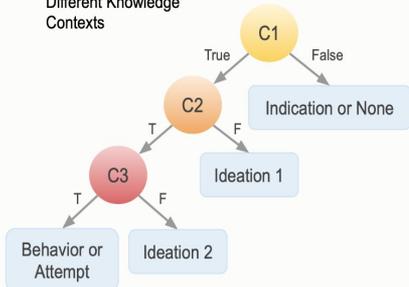
Triples

Codes	Triples (subject-predicate-object)
Suboxone used by injection, negative experience	Suboxone injection-causes-Cephalalgia
Suboxone used by injection, amount	Suboxone injection-dosage amount-2mg
Suboxone used by injection, positive experience	Suboxone injection-has_side_effect-Euphoria

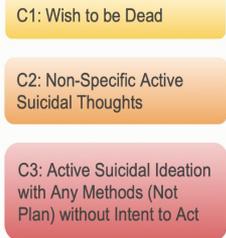
Ontology as inference for analyzing web-based data and use the extracted wisdom to inform public health surveillance as insights and actionable items.

Application in Web & Health- Suicidality Intervention Planning using Social Media

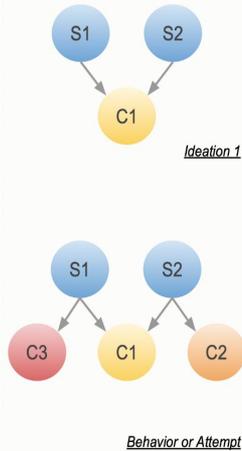
(a) Tree Paths Representing Different Knowledge Contexts



(b) Columbia Suicide Severity Rating Scale (CSSRS) Concepts



(d) Sentence-Concept Graph Contexts



(c) Post X1

S1: I don't feel like waking up anymore → **Concept 1 (T)**
 S2: It wouldn't be the worst thing if I didn't wake up honestly → **Concept 1 (T)**
 Context: **Concept 1 (T)** → Ideation1

Post X2

S1: I could jump off the ledge I am sitting on → **Concept 1 (T), Concept 2 (T), Concept 3 (T)**
 S2: Or I could do it with the gun on my lap → **Concept 1 (T), Concept 2 (T), Concept 3 (T)**
 Context: **Concept 1 (T), Concept 2 (T), Concept 3 (T)** → Behavior or Attempt



Challenges - Explainable and safety constrained reasoning over medically valid concepts

NSAI - Leverage patterns in the data to ground symbols in tree paths for use by the planner to plan intervention strategy (search).

KiNSAI - It is crucial to utilize standardize medical concepts as tree variables and the branching structure accepted by the medical community.

Eg: Suicidality Intervention using Graph Context

Takeaways

Statistical AI alone is not enough

Causal AI can be used for generating explanations

Causal AI can be used for complex causal pattern extraction

Causal AI can be used for causal entity associations

Causal AI can be used for intervention planning using web data in the application area of epidemiology, mental health, as examples

A decorative graphic consisting of a network of nodes and connections. The nodes are represented by small circles, some of which are highlighted in blue. The connections are thin lines forming a complex web. This graphic is positioned in the top-left and bottom-right corners of the slide.

Thank You