

Perspective for
AI as “Assisted Intelligence”
using Graphs
OpenEHR project

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“ AI ? ”

- Artificial Intelligence
- Assisted Intelligence

“Artificial” Intelligence

- Take a large collection of cases having been evaluated by human experts, e.g. 100.000 cases.
- Compare a new case with the reference collection and seek similarities.
- This comparison is done by a mathematical procedure, appearing as a magic black box.
- There is here no knowledge about biology and medicine, just probabilities based on a few criteria.
- It can work on large populations but exceptions could be easily missed.

“Assisted” Intelligence

- Make an extension to the human mind of experts.
- The human mind is in fact a large graph of interconnected neurons.
Graph are a very natural way to represent complex problems.
- Visual presentations of graphs are expected to be very easy to understand and to **manipulate**.

Challenges

- Today a very large amount of medical knowledge is already available in textbooks and on Internet, (although more research remains of course necessary).
- But the challenge is how to make meaningful use of this huge knowledge ?
- In charge of a new case how to get access to the appropriate knowledge ?
- Medicine used to be an “art”, the challenge is now how to process the available knowledge correctly and more precisely ?

1.A Knowledge graph of problems

- Observations > Problems or diagnoses
- From the point of view of an observation, it may be known as “suggesting” several potential problems.
- From a diagnose, or simply a “problem”, point of view, it may be known as the “having” usually several symptoms.
- All these relations may have many properties as how strong, how credible, how frequent, etc...

The symptom Respiratory Insufficiency may be caused by

- Bacterial pneumonia
- Virus, as COVID-19
- Vascular, as long emboly, heart insufficiency
- Volume restriction, as in case of pneumothorax, pleurisy,
- Obstruction of airway, as asthma, BCPO,
- etc

The disease COVID-19 may often have

- Dyspnea,
- Fever,
- Cough,
- Headache,
- Myalgia,
- Anosmia, ageusia,
- Nausea,
- etc

1.B Knowledge of recommended Actions

- Problem > Actions
- Starting from a Problem, what are the recommended Actions ?
- Starting from an Action, What are the expected useful effects and negative side effects ?

2 Current patient information

- The patient arrive with a few symptoms.
- What are the potential Problems ?
- For every Problem which Actions are to be considered ?
 - * Asking more information ? More questions ?
Lab ? RX Images ?
 - * Prescribing treatments ?
- And reevaluations in function of the results of theses Actions.

Knowledge representation

- Of course by means of traditional texts, but Natural Language processing by computers remains difficult.
- Graphs can be better understood by both humans and computers.
The conversion of available knowledge into graph format will require a huge amount of work.
- Graphs emphasize the relations between concepts.

Concepts

- Concepts are represented by nodes.
- Use of existing ontologies, UMLS, ICD, LOINC, MIMIC database, etc ...
- Concepts have labels as Patient, Observation, Problem, Action, HC professional, user, ...
- On a visual presentation, the type of concept can be quickly understood by means of shape, colour, thickness, borders, etc...
- Flying on a node can show the details of the content of the node. A concept may have attributes and may include text, images, procedures, ...

Relations

- Relations are represented by arrows between nodes.
- Relations may have attributes, degree of certainty, intensity, etc...
- In case different authors would have different opinions, the same 2 nodes could be linked by more than one relation.

Navigation in a graph

- Clicking on a node allows to navigate to the relations of this node, then to more relations in the graph, and so on.
- Any related topic may appear as a relation, in fact in a N dimensional space.
- A considered problem can lead to recommendations of actions, as request for more observations in order to confirm or exclude the suspected hypothesis.
- The identification of a problem can lead to recommendations about possible treatments.
- A treatment can lead to how it works as well to negative side effects.

Logical processing of a graph

- Graph technologies software, as Neo4j, can process graph structures.
- Tools are available in order to seek similitude, to discover patterns, to make recommendations, etc...
- This is why both scientific knowledge and current patient information need to be converted to graph format.

Research

- The main goal is to improve the precision about relations between concepts. Make the relations more objective and more precise.
- Graphs may help to discover unsuspected patterns of diseases
- What most matter is to improve the “medical methodology” about how to use the available knowledge.

Scenarios of applications

- Education:
Training of medical students. Given what is already known about the patient, discussions about what to do next?
- Telemedicine assistance in remote areas:
Provide advices where there are no specialists nor even doctors.
- Safety warnings:
Risks of side effects of treatments in function of the patient profile.
- Support of research projects

Road map: Experimental stage

- Currently working on experimental prototypes, not yet available on Internet.
- The projects “graphEHR” and “Interactive Medical Minds Maps” of the International Society for Telemedicine are very similar.

Road map: Pilot project

- After the experimental stage, a pilot project will be installed as an extension of an existing medical network,
- May be GNUHealth in Open Source ?
Symptoms, Diagnoses and Treatments could appear as nodes in the graph ?
The relations between these nodes will explain the “WHY” between these concepts.

Road map: Deployment stage

- In the future in my own opinion 2 groups of actors could be foreseen:
- At one side a scientific community maintaining the knowledge graphs, as an academic not for profit organization. Independence is here a key to be trusted.
- At the other side regional operators providing installation, training and maintenance services.

Conclusions

- Graph technologies are expected to become very useful for “medical reasoning” in order to improve the handling of available medical knowledge.
- Join us, all ideas and suggestions are very welcome for know-how exchange in Open Source.

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