Perspective for AI as “Assisted Intelligence” using Graphs

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Current Problems

- Many medical record software are available.
- Up to now most medical record systems provide archives. Like traditional reports on paper, but much easier to manage and to share.
- Much medical knowledge is available on Internet.
- Many standards have been developed e.g. ICD, OpenEHR, Snomed, ICPC, etc…
- But in developing regions there are very few doctors to process the information.
AI as “Artificial Intelligence“

- Based on very large collection of reference material, e.g. Xray images.
- The advantage of Artificial Intelligence is here that the machine is very fast to compare a new sample to the reference collection.
- Black box mathematical models can be very useful, but have no idea about the medical domain. Lack of understanding of the context and lack of "common sense".
- The quality is as good as the quality of the experts who did prepare the collection of references.
AI as “Assisted Intelligence“

- Start from existing medical knowledge and provide help about how to manage the information.
- Human natural intelligence is based on large network of neurons with many complex connections.

- The challenge is how to assist the human process of managing the information step by step.
- Particularly in regions where there are very few doctors.
Managing medical information

• Task oriented information management. The first goal is of course to solve health problems.

• Need to structure information about the patient and not just a narrative descriptions.

• Need to make a clear difference between:
  * Observations,
  * Health Issues,
  * Objectives,
  * Actions.
Information Handling Tools

• Patient record:
  The situation of a particular patient

• Textbooks:
  The description of diseases, with known features, complaints and observations.

• Graphs:
  An easy way to join these 2 points of view.
Graphs

• Nodes:
  Represent concepts, with full description and attributes. (patient, high blood sugar, diabetes knowledge, ....)

• Relations:
  What most matter is the relation between concepts. (Patient → fever → infection, ...
1. Knowledge of Observations

- Raw facts here without any judgement. (complaints of pain, auscultation, lab test, ...)
- Observations concepts are in principle known with a meaning and relations to other concepts.
- Any Observation can suggest one or a set of possible classes of suspected Health Issues.
- At least when above a minimum threshold.
2. Knowledge of Health Issues

• Any disease is known to have a given set of symptoms with their relative frequency and importance in the diagnosis.

• Some symptoms or observations are known to be relevant and their importance should be quantified.

• As well positive factors, increasing the probability,
As well negative factors, excluding the disease.
3. Knowledge about Actions

- Definition of the Action (Ask a question, order an Xray, prescribe, ...),
- Expected results,
- Costs (delay, risks, inconvenience, price, ...)

Relations between the 3 classes
Iterative Care Process

• (1) Get the available observations about the patient.

• (2) Identify and evaluate the current suspected Health Issues

• (3) Recommend Actions to do next (seeking more information or prescribing treatments)

• (4) Take the results of the Actions and start the next iteration.
Navigation in a graph

- Graphs allow easy retrieval of information from diverse point of views:
- Type of information: observation, Health Issue, Action,
- Anatomical domain (respiratory, cardio-vascular, etc...)
- Functional point of view (infection, tumor, etc...)
- Time,
- Author
- Location of the contact
- ....
Methodology

• Seek how far there is a match between the available observations of the current patient and some suspected Health Issue patterns.

• Relevant information from the Observation side are often missing.

• Step by step, make recommendations about seeking additional information in function of the currently suspected Health Issues, in order to certainty.
Weighted Evaluations

• Having a set of Observations try to compute a scores of probability and certainty, of the currently suspected Health Issues.

• Take account of many factors:
  Intensity,
  Frequency,
  Duration,
  Credibility of the source,
  ……

• Visual representation, e.g. thickness of arrows, color, …
Experimental Prototype on Internet

- A server is in preparation in order to allow interested participants from wherever in the world, to play with this kind of new tools.

- Follow up of fictitious typical patients will be discussed.

- To be published as Open Source, using tools as the Neo4j and VISJS community version.

- Unfortunately it is not yet operational on the Web. Only a preliminary prototype, editing edges, scaling, ...
Weighted Recommendations

• Every Health Issue is in principle known with relations to a set of recommended Actions.

• These links have weights depending on: Expected benefits, Risks and costs, Care objectives

…..
Recommendation graph
Assisted Recommendations

• The recommendations must be explained step by step. Again visual cues can be very useful, e.g. size, color, shape, ...

• Again the recommendations are as good as the experts in the background, maintaining the “Assisted Intelligence”.

• At the end the human user makes his mind in the local context.
Research

- When graphs will become available about large populations of patients, analysis will become possible.
- Graps could allow the discovery of unexpected patterns. (example).
- This research will improve the decision model step by step.
Conclusions

- The human logic of handling medical information is in fact based on graphs with many relations.
- Textbooks can be represented as graphs with weighted relations.
- The relations between patient information and knowledge can be represented as graphs.
- Graphs explaining the logic are expected to contribute to continued education particularly in developing regions.
“Open Source”,
“Open Data”,
“Open Medical Reasoning”?