Perspective for AI as “Assisted Intelligence” using Graphs

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Current Problems

- Many medical record software are avaible.
- Up to now most medical record systems provide archives. Like traditional reports on paper, but much esier 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 sence”.
- 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 region 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 treshold.

2. Knowledge of Health Issues

- Any disease is known to have a given set of symptoms with their relative frequency and importance in the diagnose.
- Some symptoms or observations are known to be relevant and their importance should be quantified.
- As well positive factors, increansing the probability,
  As well negative factors, exluding the disease.

3. Knowledge about Actions

- Definition of the Action (Ask a question, order an Xray, prescribe, …),
- Expected results,
- Costs (delay, risks, incovenience, 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 divese point of views:
- Type of information: observation, Health Issue, Action,
- Anatomical domain (respratory, cardio-vascular, etc...)
- Functional point of view (infection, tumor, etc...)
- Time,
- Author
- Location of the contact
- ……

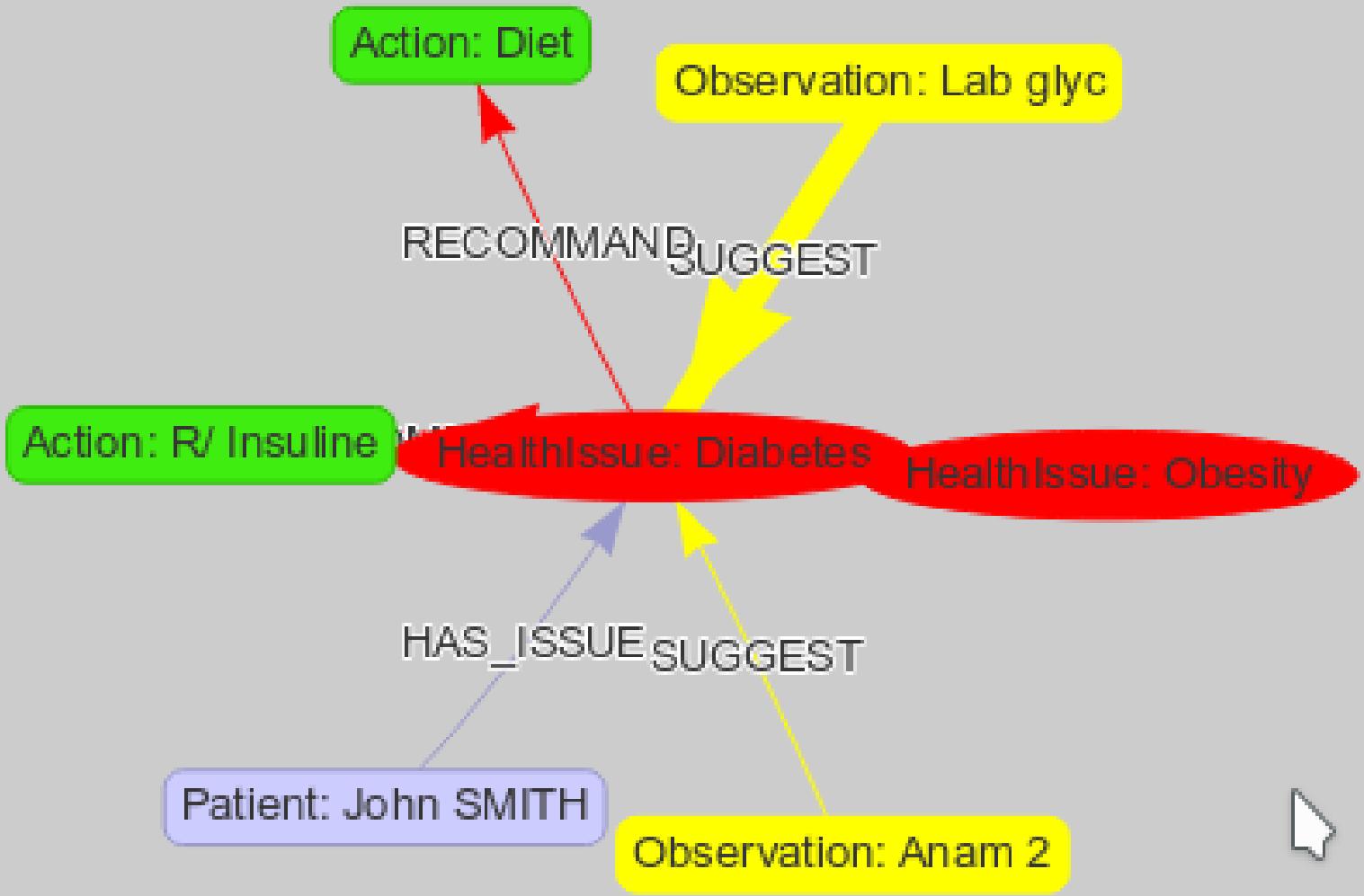
Methodology

- 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, ...


Patient_group: Patient Group
Agent: Dr Charcot
Event: 1 Dec 2015
Observation: Lab: Hb
Observation: Ex: BP
Observation: Ex: Weight
Observation: Anam 4
Observation: RX: Thorax
Action: rx tomography
Observation: Anam 7
HealthIssue: Pulmonary tumor ?
Event: 2 July 2015
Action: brochoscopy
Patient: John SMITH
Action: lab expectoration
HealthIssue: Tuberculosis ?
Action: RI Insuline
Observation: Anam 1
Observation: Lab glyc
Observation: Ex: Temperature
HealthIssue: Diabetes
Action: Diet
Event: 3 Sept 2015
Observation: Anam 2
TIME
DID
INCLUDE
HAS_OBS
HAS_EVENT
HAS_ACTION
HAS_ISSUE
SUGGEST
RECOMMAND


Action: Diet
Observation: Lab glyc
RECOMMAND
SUGGEST
Action: R/ Insuline
HealthIssue: Diabetes
HealthIssue: Obesity
HAS_ISSUE
SUGGEST
Patient: John SMITH
Observation: Anam 2

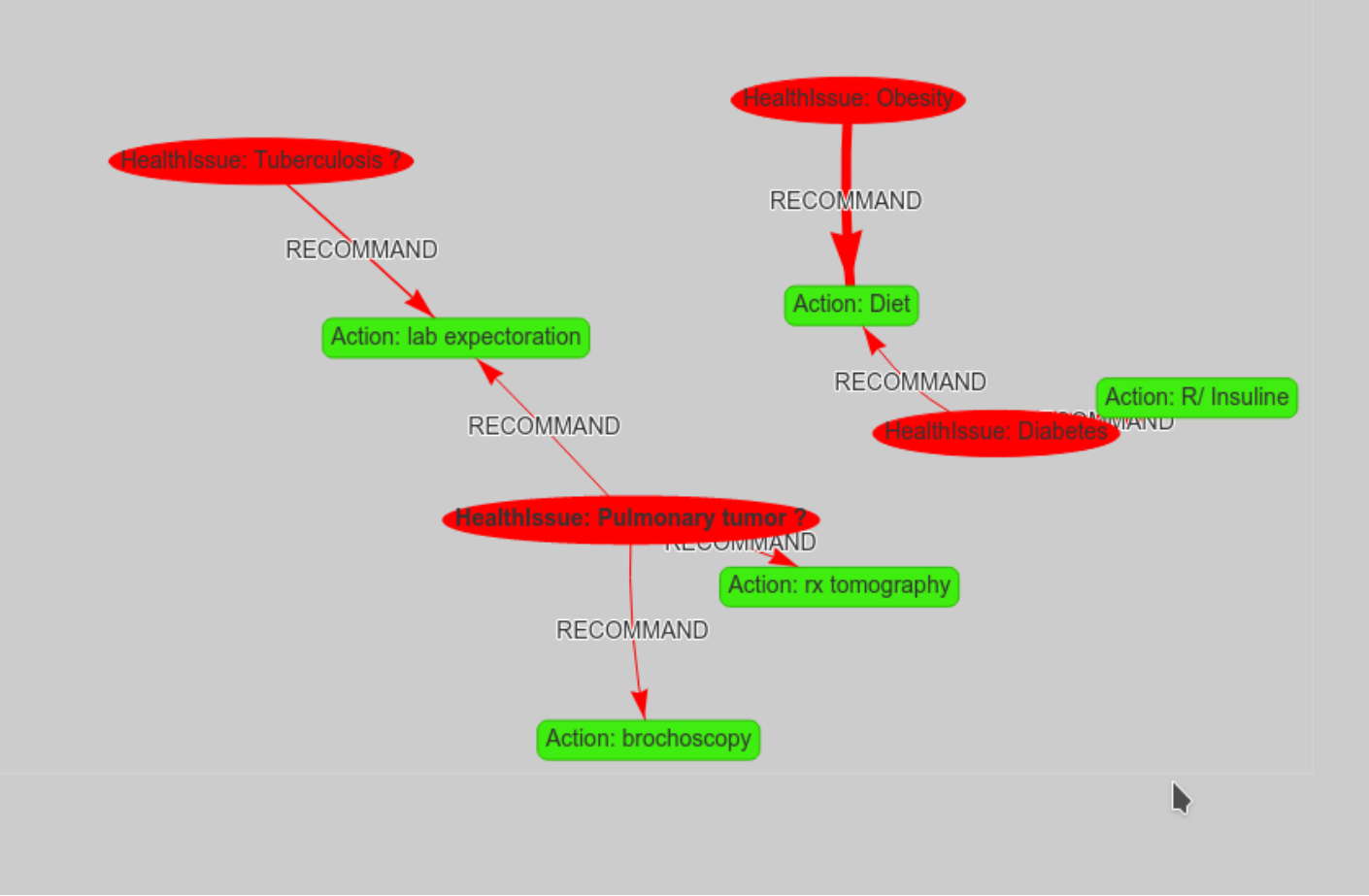
Experimental Prototype on Internet

- 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 fictious typical patients will be discussed.
- To be published as Open Source, using tolls as the Neo4j and VISJS community version.
- Unfortunately it is not yet operational on the Web. Only a preliminary protype, 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” ?