Decision making through argumentation explanation

All the arguments are generated according to the medical rules defined. The arguments are represented in first order logic. There are two parts of an argument, the claim or the degree of belief and support. In case of our medical domain all the symptoms or the evidence are not dependent on each other with a cause and effect relationship; but they are directly related to diagnosis (decision) with that relationship.

Eg: Let's say we are diagnosing a patient for a disease and there are three possible outcome such as dengue, malaria and chikungunya. Following are the sample arguments generated after seeking information from the patient.

Arg1: If patient's platletCount < 100 L/mm^3 ➔ support (dengue, 0.8)

RHS: It is the claim which believes that patient have 80% chance of being infected with dengue.
LHS: It is the support for the claim in RHS based on patient's input.

It is also possible to have multiple claim based on the support.

Arg2: *If patient's bodyTemp > 100 F and numberOfDays > 7 ➔ support (dengue, 0.5) and support(malaria,0.3)*

In this model we consider the degree of belief of the argument about the truth and not for false, will show in the example how.

Arg3: if patient's "98.6 F< bodyTemp < 100 F" and numberOfDays< 4 ➔ *support (not dengue. 0.8)*

Although this belief seems to be about false, but it is actually saying *support (dengue, malaria, 0.8).* It says nothing about dengue, as we have no reason to believe that the patient has dengue. So, probability of dengue would be 0 and probability of whole sample space (frame of discernment in case of the theory which we would be using.) would be 0.2.

Now these arguments can be generated some may support each other and some may attach each other like Arg3 attacks Arg1. So to find a conclusion we need to fuse all the evidences. To do that we will using a decision theory. I will be using Dempster-Shafer theory to combine all and get the evidence.

Pseudo Code

Decision: Disease

Situation: Fever

Goal: Determine_the_disease

Candidates: Dengue; Malaria; Chikangunya

Arguments:

Arg1: If patient's platletCount < 100 L/mm^3 ➔ support (dengue, 0.8)

Arg2: *If patient's bodyTemp > 100 F and numberOfDays > 7 ➔ support (dengue, 0.5) and support(malaria,0.3)*

Arg3: if patient's "98.6 F< bodyTemp < 100 F" and numberOfDays< 4 ➔ *support (not dengue. 0.8)*

Commits : Netsupport(X,Y) & netsupport (Z,A) & netsupport(B,C)

A decision maker considers the decision (diagnosis) in for activation when the belief (any argument) is added to the knowledge base. When the decision maker detects this, it checks whether any candidate has already been committed. If not, the decision will be activated and the goal will be determine_the_disease is raised; otherwise no action is taken. While the goal is raised, further information about the situation can be examined to determine whether the premises of any argument schemas are instantiated.

The netsupport function evaluates collections of arguments for and against any candidate to yield an overall assessment of confidence and establish an ordering over the set of candidates.This ordering may be based on qualitative criteria or on quantitative assessment of the strength of the arguments. This candidate has a form *netsupport(<candidate>, <support>)*

The net support is the aggregation of all the arguments and will be done using dempster-shafer theory for that.

Dempster- Shafer Theory

The Dempster-Shafer theory , also known as the theory of belief functions, is a generalization of the Bayesian theory of subjective probability, to combine cumulative evidence or to change prior opinions in the light of new evidence.

Let Ω be a finite set of mutually exclusive and exhaustive propositions, called the frame-of-discernment, about some problem domain (Ω ={malaria, dengue, chikangunya} in our example decision making problem) and ∏(Ω) is be the power set of Ω. A basic probability assignment (BPA), m: ∏ (Ω) -* [0,1], is used to quantize the belief committed to a particular subset A of the frame of discernment given certain evidence. The probability number m(A) says how much belief there is that some member of A is in fact the case, where

$$M(\text{phi}) = 0 \text{ and } \sum m(A) = 1 \text{ , where A is subset of } \Omega$$

For any set where A is subset of Ω for which m(A) ≠ 0, A is called the focal element.

The measure of total belief commited to “A is subset of Ω” can be obtained by computing the belief function *Bel* which simply adds the mass of all subsets of A.

$$Bel(A) = \sum m(B) \text{ , where B is a subset of A}$$

Single belief function represent the lower limit of the true probability and the following plausibility function represent the upper limit of the probablilty:

$$Pl(A) = \sum m(B)= 1- Bel(A^c) \text{, where } A^c \text{ is the complement of A}$$

Two independent evidences expressed as BPAs m1 and m2 can be combined into single joint basic assignment m by Dempster’s rule of combination.

$$M_{1,2}(A) = [\sum_{B\cap C=A} m_1(B)m_2(C) / 1- \sum_{B\cap C=phi} m_1(B)m_2(C)] \text{ , where } A \neq phi$$

Or

$$M_{1,2} (A) =0 \text{ , where } A = phi$$

Now based on the final table with belief (lower probability) and plausibility (upper probability) we will select our final candidate.

Eg:

Below is the final table of belief

Focal Element(A)	Bel(A)	Pl(A)
{dengue}	0.62	0.77
{Malaria}	0.16	0.38
{Chikangunya, Malaria}	0.23	0.38
{dengue, malaria}	0.89	1.0
Ω	1.0	1.0

The actual probability lies somewhere in between so final decision can be made of the basis of the following criteria

1. Prob= (Bel(A)+Pl(A))/2 , for all and select the highest prob candidate, which shows it has more evidence to support this decision.
2. If the mean is same for any the candidate then we will Max-min function, that means will pick up the lower probability and select the highest of them. This will again show that we have enough evidence to support that at least the final decision is true under available evidence.
3. If any two candidates have the same upper and lower probability then it shows we do not have enough evidence to overpower another decision. So we give both the results.