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Mots-clés : *Pluggable Alert System, Linguistic Variables*

Alerts' Detection Using Linguistic Variables and Modifiers

Context

Medical staff reasoning employs *linguistic concepts* to deal with patient information (*young, tall, fat, etc.*) instead of numerical ones (14 years, 200 cm, 120 Kg, etc.) as it is proposed in commercial Medical Information Systems.

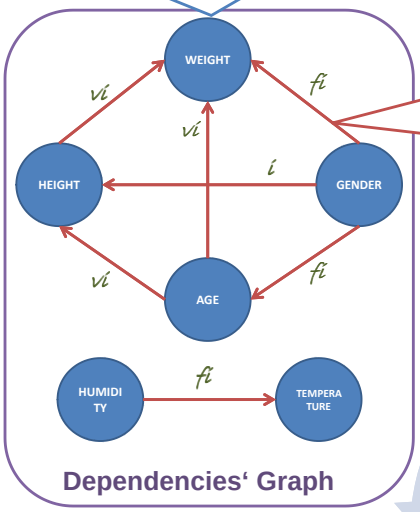
Using Linguistic Variables improves the *expressivity* of medical sentences.

Let's take this two sentences referring to the same patient:
"The patient Px is young and fat"
"The patient Px is 15 years old and weights 70 Kg"

The first message can be understood by any doctor belonging to any medical domain, and even by people from non-medical domains.
On the other hand the second message requires a minimal (in this case) knowledge about the relation between age and weight. Further, it is not possible to conclude that the patient Px is fat if the height value is unknown. In this case there is an implicit relationship among the age, height and weight.

P.A.S.

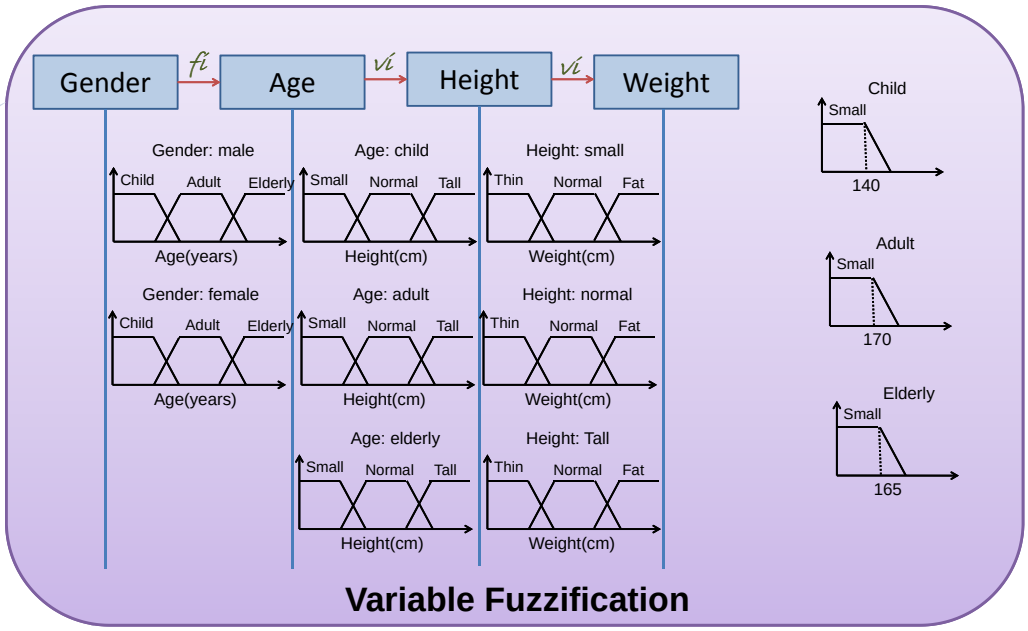
Linguistic Variable:
Linguistic variables have a set of linguistic values. For example, *child*, *adult* and *elderly* could be the values for the *age variable* in cardiology. In pediatrics, a fourth value like *newborn* could be useful.



Dependencies' Graph

Modifiers:
Variable linguistic values in most of cases are *modified* by other variable values. We can't assert that a person measuring 170 cm is tall if we don't know if he is a child, adult or an elderly person.

Modification occurs at different *importance levels*: Very Important, Important and Fairly Important.



Variable Fuzzification

$$RW_{vi} = 2RW_i = 3RW_{fi} \quad (1)$$

$$N_{vi} * RW_{vi} + N_i * RW_i + N_{fi} * RW_{fi} = 1 \quad (2)$$

Where RW_{vi}, RW_i and RW_{fi} are the relative importance weight of variable modification and N_{vi}, N_i and N_{fi} the Number of variables being modified with the respective importance.

$$MD_{Fv_n} = \left(\sum_{i=1}^{n-1} MD_{v_i} * RW(v_i, v_{i+1})\right) + (MD_{v_n} * RW_{vi}) \quad (3)$$

Where v_{i-1} modifies v_i, $RW(v_i, v_{i+1})$ is the relative importance Weight of the variable modification and v_1 is not modified by any other variable

$$TL_{Fv_n} = \frac{P_i}{\sum P_j} \quad (4)$$

Where P_i and P_j are graph paths leading in variable v_n and

$$P_i = \sum_{i=1}^{n-1} RW(v_i, v_{i+1})$$

If a variable value is MISSING the TL of this path will be zero and the LL and MD will be calculated using the historical Data Base

The Highest TL will be chosen as the TL of the variable and also the MD of the respectively path

TL: Trust Level
AL: Applicability Level
MD: Membership Degree
LL: Linguistic Label

Alerts

$$Heat\_Alert: (age \geq elderly; i) AND\ (weight \geq fat;\ fi) AND (temperature \geq very\_hot; vi)$$

$$N_{vi} * RW_{vi} + N_i * RW_i + N_{fi} * RW_{fi} = 1 \quad (5)$$

Where N_{vi}, N_i and N_{fi} are the Number of variables with the respective importance in the alert

$$AL_{alert} = \sum_{i}^{alert} MD_{Fv_i} * RW(v_i) \quad (6)$$

Where $RW(v_i)$ is the relative weight of the importance of variable v_i in the alert

$$TL_{alert} = \sum_{i}^{alert} TL_{Fv_i} * RW(v_i) \quad (7)$$

Where $RW(v_i)$ is the relative weight of the importance of variable v_i in the alert

P.A.S. Extensions

Alert detection occurs over different contexts. A context is composed by: a group of patients; a dependency graph; and an alert involving some graph variables.

References

W. Manzi de Arantes, C. Verdier, "Defining Quality-Measurable Medical Alerts From Incomplete Data Trough Fuzzy Linguistic Variables and Modifiers", *IEEE Trans. on Information Tech. in Biomedicine*, vol 14, no 4, pp. 916-922, July 2010