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Representation of Knowledge: Probabilistic Reasoning and Fuzzy Logic for the Knowledge Representation of Gastrointestinal Tract Infections

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Abstract

This paper presents different representation technique and converts knowledge of gastrointestinal tract infections in the form of probability tables, which describes the evidence of certain disease against some specific symptoms Also certainty factor table to handle fuzziness. In this study, representation task is a linguistic modeling work, the tool for intelligent actions that should have expressive power for unambiguous description of the environment, suitability for reasoning in the directions of certain goals and efficiency in use for problem solving, like real-time applications. Logical sentences are represented by verbal, formulary, and graphical schemes, i.e., patterns, the variables of the scheme are the original patterns.

Keywords: Fuzzy Logic, Gastrointestinal tract infections,, Deduction, Induction, Diarrhea, Reasoning , probabilistic reasoning

1. Introduction

An expert, either a human or a machine, has her/his/its particular value by her/his/its knowledge. Though knowledge is always related to some special disciplines, professions, and/or experience, knowledge of any art has some generic features that define how this knowledge is acquainted, how it can be accessed, and how it can be applied to certain problems that are not totally identical to the earlier acquainted cases, i.e., learning, storing, retrieving, and reasoning methods based on knowledge.

These generic features of knowledge are embodied in representation. A system, human or machine, in the process of learning (respectively input operations) stores the objects, actions, concepts, situations, and their relations in some representation form in the brain, respectively in the computer memory. This stored knowledge is used by retrieval (remembering), combination (association), and/or reasoning. If the computer was the same device as the human brain, the representation problem would be a biological and psychological task for achieving the best imitation. This is fortunately or unfortunately not the case; we can use only some analogies, metaphors between the brain and the computer; one should be always very careful as to how far these analogies work. On the other hand, the knowledge of the computer, which is really a directly or indirectly transferred human knowledge, is and should be some approximate copy of the human knowledge, transferred to another representation medium and by that way to another representation form.

This Study estimates the relevance and difficulty of knowledge representation. Even the human origin is uncertain. The phenomena of the world, like the performance of a mechanical machine, of a living organism, the economy, or social relations are represented in the human brain by the signals of the sensory inputs like vision and touching, and by attaching those to representations of earlier inputs. The sensory representation, only at the second phase of the representation process: the mental one. The third phase is the verbal representation and mental representation, is not the same as the verbal representation.

This verbal representation should be transformed into computer programs, using the basic means of mathematical conceptual apparatus. The representation problem is, by that way, a highly complex and highly practical one: computer representation surpass these dim relations, and get a practically applicable device. Logical sentences are represented by verbal, formulary, and graphical schemes, i.e., patterns, the variables of the scheme are the original patterns.

2. What is Logic?

Logic has had great influence on the development of expert systems, but its role has often been implicit rather than explicit, and that influence has not always been clearly described or understood. One reason is that the concept of logic is quite broad, and it is sometimes difficult to keep all of its important aspects in mind when considering the role and use of logic in knowledgebase systems applications. Another reason is that logic was originally developed as an abstract description of reasoning, and has only recently been widely adapted for use as a computational system. As stated by a pioneer of using logic for computation, Alan Robinson has described logic as "the science of what follows from what." In other words, logic is about what kinds of conclusions can be reasonably drawn from what one already knows.

Even on the basis of that informal (but concise!) definition, the relationship to expert systems is clear. Logic provides a tool for both the analysis of expert reasoning, and for the articulation and use of what is known about a problem for which expertise is required: logic is about the relationship between what is known, and how what is known can be deployed to reason

about problems and situations. To understand logic and its role in expert systems is to first dispel some of the many misconceptions about logic. One is that logic is only about reasoning. The fault behind that misconception is that one cannot practically reason without knowing about something. Even the simplest syllogisms are little more than syntactically obvious without interpretation: "All men are mortal; Socrates is a man, therefore Socrates is mortal," is much more instructive than the relatively sterile "A implies B; A, therefore B." Similarly, logic is not preoccupied with syntax, or the form in which what one knows is expressed. This misconception arises only when one misconstrues the particular *form* of knowledge with the reasoning itself.

3. Logic and Reasoning

Logic studies the principles of reasoning. As a scientific discipline, logic has found a wide range of applications in many disciplines, which include computer science and artificial intelligence (gen_and_nil). In the design of AI systems, logic has often been regarded as one of several knowledge tools.

- By Deduction
- By induction

3.1 Deduction

Logical inference or deduction is the classical approach to reasoning. Knowledge base that is a set of logic formulae and one or more sound inference rules from which one can derive new knowledge and add to the knowledge base. As a transformation of a given knowledge base, deduction (or deductive rules of inference that define a deductive proof procedure) has the property of preserving truth: sound rules of inference will preserve the truth of original information in deduced information. From another view, deduction forms the basis upon which AI-motivated extensions can be constructed.

3.2 Induction

Inductive reasoning is not necessarily sound. Although an inductive conclusion must be consistent with the formulae in the background theory and knowledge base, it need not be a logical consequence of these formulae, although not every induction conclusion is unsound. Thus, inductive inference is a type of no monotonic reasoning.

4 Fuzzy Logic

Fuzzy-type uncertainty measure, expressed in verbal form, is transferred to the same types of numerical representation; the meaning is, on the one hand, a philosophical explanation, beyond the computer representation process; on the other hand, it is a simple look-up table representation attaching the *0* to *1* values to different verbal set membership measures. The interpretations of the nature of uncertainty, the use of different uncertainty models deviate at *combination, propagation* process. An attempt for a unified graph representation form is the use of probabilistic (uncertainty) networks by Pearl (1988).

The outcome of any uncertainty combination-propagation calculation is used in two ways: the first provides a "certain" resulting value used for decision. If two or more different methods or different time medical checks indicate certain evidence, then the resulting evidence will be higher. How high depends on the uncertainty model and the related calculation algorithm. The same is the case in the multiple evidences of a legal case, a hypothesized outcome of

different interventions and situations in economy, etc. This means that the earlier outlined logical structures remain the same, only this outcome chosen in a somehow arbitrary way, is embedded.

The second use of uncertainty combination-propagation results can be useful if different trials are feasible, either in a model calculation or in real life experimentation. In the latter case a typical application is the selection of different medical diagnostic and therapeutical strategies. Led by considerations of least expenses, least possible harm and suffering of the patient, by least risk for the doctor and an unrecoverable deterioration, different strategies can be used with different uncertain but somehow estimable effects, starting from nonintervention to an immediate radical operation, using milder or extremely radical pharmaceutics. In this representation the action branches of a decision tree are taken one after the other according to the resulting uncertainty values. The two types of outcomes are not contradictory, and can apply the same method. The application being different influences the responsibility, risk-related estimations of the uncertainty values.

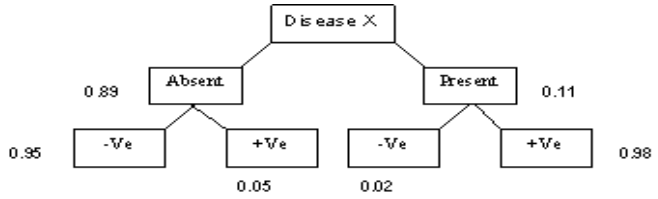
As was emphasized, the calculation method of combination-propagation is a basic representation issue, representing the general model of the nature of uncertainty. This very relevant fact is forgotten several times. To make it clear: where reliable statistics are available and the risk of a single decision is not high (moreover, if some experimentation with different possible decisions is possible), the best is a *classical probabilistic model* representation, which is a well-defined model on well-defined, mutually independent events having clear-cut truth values, excluding any intermediate situations. In this case, highly sophisticated estimation methods are available for the distribution of event data, confidence on them, expected failures. Problems of mass production, like quality control, are typical examples of application areas. The observations of physical and chemical phenomena

A classic probabilistic-related model is the Bayesian; it concerns certain classes of events within the realm of the total observation. The *Bayesian model* supposes also well-defined classes, reliable sampling methods, and a relevant amount of data for each class. The condition of *independence* belongs also to the model hypothesis. The Bayesian model establishes the well-known relation between a priori and a posteriori estimations, i.e., probability of an effect, if we know the probability of a certain cause, and vice versa, the probability of a cause based on the known probability of an effect. The Bayesian method established relations between a *priori* and a *posteriori* probabilities, i.e., between two events which are cause and consequence related and vice versa.

5 Bayesian Probabilistic Inference

This portion is the soul of MES without this portion MES is just like a dead person. This portion is consisting of algorithms & AI technique. MES inference Engine performs Probabilistic reasoning so called **Belief Networks or Bayesian Networks.** s a Bayesian Network from probabilities about infection under some symptoms from probability tables stored in the knowledge base, applies algorithm i.e. it matches the symptoms given by user if matches calculate its probability & on the basis of probability, It ranks all the possible causes in order of decreasing probability to user interface part. An example is here for a disease X what is the chance of its present and absent in a specific case. The diagram shows that the probability of some –ve bacteria is 0.95 if it is absent and 0.02 if it is present given that the disease is disease X.

Fig 1 Bayesian Probabilistic Inference



6 The employment of proper techniques to elicits knowledge.

The approach used for knowledge acquisition determines both the quality of knowledge and the amount of effort required for its acquisition, so the technique selected greatly affects the performance of the expert system and the resources required for its development. To achieve the above goal, we have to perform the following tasks.

- Selection of domain experts
- selection of knowledge engineers
- Interviews with experts & end-Users.

I. Two solutions can find after these interviews sessions:

One is the Clinical Approach in which Doctors usually diagnose heuristically or somewhat on their previous experiences related to that particular disease.

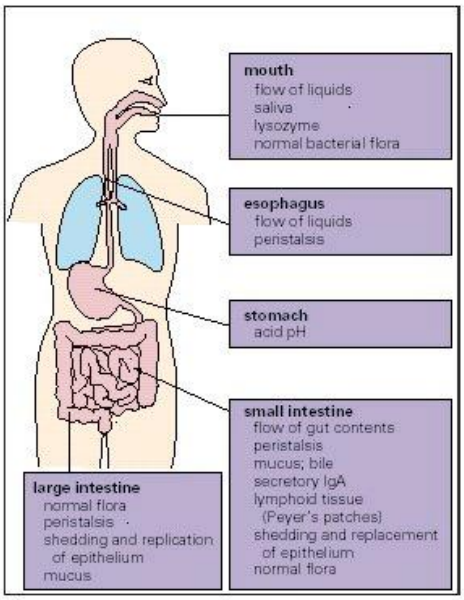
II. Second is the pathological approach which is based on the lab test conducted in the Medical laboratories, on the basis of these test reports diagnosis has been performed.

7 Gastrointestinal tract infections

Gastrointestinal tract constitutes of Gastro (Stomach) and Intestinal part, including small and large intestine.As with different parts of body GIT is susceptible to many bacterial infections.

The bacteria that causes infections in GIT are usually belong to GRAM NEGATIVE group.

Fig 2 Gastrointestinal tract infections



Every day we swallow large numbers of microorganisms. Because of the body's defense mechanisms, however, they rarely succeed in surviving the passage to the intestine in sufficient numbers to cause infection.

7.1 Diarrheal disease

Three clinical presentations of Diarrheal disease may require Treatment with antimicrobials: acute watery diarrhea, invasive diarrhea (dysentery) and persistent diarrhea.

7.1.1 Acute watery diarrhea

Most cases of acute watery diarrhea are caused by rotavirus and do not require treatment with antimicrobials. Antimicrobial treatment is indicated, however, in cases due to infection with *Vibrio cholera*. All cases of watery diarrhea require measures for the prevention and treatment of dehydration. Adequate nutrition should be maintained.

7.1.1.1 Cholera

Cholera is caused by *Vibrio cholera* and is characterized by severe acute watery diarrhea. Several liters of fluid may be lost within a few hours, causing severe dehydration. Cholera occurs in endemic and epidemic situations. The antimicrobial susceptibility of the local strains must be determined and multiple isolates tested during the course of an outbreak to confirm susceptibility. It is now recognized that as many as 90% of patients with cholera require no more treatment than prompt and adequate oral replacement of the water and electrolytes lost in the Diarrheal stool and vomits. Those who are severely dehydrated require intravenous fluids and antimicrobials.

7.1.2 Treatment

Doxycycline 300 mg (children >8 years: 2mg/kg; maximum 100mg) orally in a single dose (contraindicated during pregnancy) *or* ciprofloxacin 1g (children:20mg/kg; maximum 1g) orally in a single dose (contraindicated during pregnancy).

7.2 Invasive diarrhea (dysentery)

In developing countries invasive diarrhea or dysentery is often due to *Shigella* spp., with less severe diarrhea caused by *Campylobacter* spp. In some countries enteroinvasive *Escherichia coli* is also common.

7.2.1 Shigellosis

The susceptibility of *Shigella* spp. varies between countries, with multiresistant strains encountered in many regions. Therapy should initially be based on data on the susceptibility of local strains and modified once the results of stool culture and susceptibility tests are known. Neonates with bloody diarrhea should be referred to hospital for treatment.

7.2.2 Treatment

Nalidixic acid 1g (children ≥3 months: 15mg/kg; maximum 1 g) orally every 6 hours for 5 days (contraindicated during pregnancy) *or* ciprofloxacin 1g (Children: 20mg/kg; maximum 1g) orally in a single dose (contraindicated during pregnancy).

7.2.3 Comments

Patients with infection due to *Shigella dysenteries* serotype 1 should receive ciprofloxacin 500 mg (children: 10mg/kg; maximum 500mg) orally every 12 hours for 5 days (contraindicated during pregnancy). Ciprofloxacin is the preferred treatment option in all cases, but because of its lower cost, nalidixic acid is used in some countries. It should be noted, however, that the use of nalidixic acid may result in reduced susceptibility of *Shigella* spp. To ciprofloxacin.

7.3 Enteritis due to Campylobacter jejuni

Many patients with enteritis due to *Campylobacter jejuni* are asymptomatic by the time the diagnosis has been established and therefore do not require treatment with antimicrobials. Treatment should only be considered for patients with persistent symptoms.

7.4 Diarrhea due to enteroinvasive Escherichia coli

Antimicrobials are generally not required for the treatment of diarrhea due to enteroinvasive *Escherichia coli*. Furthermore, there is some evidence to suggest that such treatment may worsen the disease.

7.5 Persistent diarrhea

In general, routine treatment of persistent diarrhea with antimicrobials is not effective and is not recommended. However, children with persistent diarrhea caused by shigellosis, amoebiasis or giardiasis, or with associated non-intestinal infections, such as pneumonia, sepsis, upper respiratory ract infections or otitis media may require antimicrobials. Such treatment should follow standard guidelines.1Severely malnourished children should receive broad-spectrum antimicrobials for several days when admitted to hospital.2 Persistent diarrhea may also be associated with HIV infection. In this situation, pathogens may include *Salmonella*, *Cryptosporidium* or *Microsporidium* spp. 1 See *The treatment of diarrhea: a manual for physicians and other senior health workers*, 3rd rev. Geneva, World Health Organization, 1995 (unpublished document WHO/CDR/95.3; available from Communicable Diseases: Control,

Prevention and Eradication, World Health Organization, 1211 Geneva 27, Switzerland). 2 See *Management of severe malnutrition — a manual for physicians and other senior health workers*. Geneva, World Health Organization, 1999.

7.6 Acute enteric infections

7.6.1 Typhoid and paratyphoid fever

Typhoid and paratyphoid fever are caused, respectively, by the pathogens *Salmonella typhi* and *S. paratyphi*, which are specific to humans. Transmission occurs via contaminated water and/or food. Following treatment with antimicrobials, about 10% of patients relapse and 1–3%
become chronic carriers of infection.

7.6.2 Treatment

Chloramphenicol 1g (children 25mg/kg; maximum 750mg) orally every 6 hours for 10–14 days *or* ciprofloxacin 500–750mg (children 10–15mg/kg; maximum 500 mg) orally every 12 hours for 5–14 days (contraindicated during pregnancy) *or* sulfamethoxazole 800mg + trimethoprim 160mg (children: 20mg/kg + 4mg/kg; maximum 800mg + 160 mg) orally every 12 hours for 3 days. *Chronic carriers* Ciprofloxacin 500–750 mg orally every 12 hours for 4–6 weeks (contraindicated during pregnancy; children: ampicillin 10mg/kg (maximum 250mg) i.m. every 6 hours for 4–6 weeks).

7.6.3 Comments

In many developing countries chloramphenicol is preferred, due to its lower cost. However, the prevalence of resistance to the drug is increasing. Ciprofloxacin is not licensed for either of these indications in children, but is frequently used in short courses. Chloramphenicol and ampicillin appear to be less effective than ciprofloxacin in treating chronic carriers of infection.However, prolonged use of ciprofloxacin in children should be avoided.

7.7 Infectious enteritis due to *Salmonella* spp. other than *S. typhi.*

In infectious enteritis due to *Salmonella enteritidis*, treatment is the same as that recommended for typhoid fever (see above). In other circumstances antimicrobial therapy is not recommended. However, chronic bacteraemia, metastatic infections or enter colitis in patients with sickle-cell disease, HIV infection or other predisposing conditions must be treated. In developing countries multiresistant salmonella infections (including septicaemia) may be nosocomial in origin, especially among children. Recommendations for antimicrobial therapy should be based on data on the susceptibility of local strains.

7.8 Enteritis due to enterotoxigenic *Escherichia coli*

Chemoprophylaxis against so-called "traveler's diarrhea" is not indicated. Mild cases require no treatment. However, antimicrobial therapy should be considered if diarrhea persists or is severe (e.g. more than five bowel movements per day, bloody diarrhea and/or fever).

7.8.1 Treatment

Sulfamethoxazole 800mg + trimethoprim 160mg (children: 20mg/kg + 4mg/kg; maximum 800mg + 160mg) orally every 12 hours for 3 days o*r*ciprofloxacin 500 mg (children:

10mg/kg; maximum 500mg) orally every 12 hours for 3 days (contraindicated during pregnancy).

7.8.2 Comments

Tetracycline, doxycycline, chloramphenicol and cephalosporin are not recommended. Ciprofloxacin is not licensed for use in children for this indication, but may be used for short courses if there are no suitable alternatives.

7.9 Intestinal protozoan infections

7.9.1 Amoebiasis

Amoebiasis is an uncommon form of bloody diarrhea due to the protozoan *Endameba histolytica*. The diagnosis should be considered if a patient has. persistent bloody diarrhea (dysentery) despite therapy for shigellosis. Only certain strains of *E. histolytica* are pathogenic and asymptomatic carriers are common in endemic areas. Patients with invasive disease require consecutive treatment with a systemically active amoebicide followed by a luminal amoebicide in order to eliminate any surviving organisms in the colon. Clearance of cysts in the faeces should be mainly considered in patients living in non endemic areas.

7.9.2 Treatment

Metronidazole 10mg/kg (maximum 250mg) orally every 8 hours for 8–10 days (adults and children; contraindicated during pregnancy) *followed by* diloxanide furoate 500mg (children: 6–7mg/kg; maximum 500 mg) orally every 8 hours for 10 days.

7.9.3 Giardiasis

Giardia lamblia is a flagellated protozoan which is transmitted from person to person mainly via faecal contamination of food or hands. It occurs worldwide, particularly where sanitation is poor, and is a common cause of both acute and persistent diarrhea among children in developing countries.

7.9.4 Treatment

Metronidazole 2g (children: 30mg/kg; maximum 1.2g) orally every 24 hours for 3 days (contraindicated during pregnancy) of *tinidazole* 2g (children:50mg/kg; maximum 2g) orally in a single dose (contraindicated during pregnancy). **Necrotizing enterocolitis due to *Clostridium difficile.*** This is a form of pseudomembranous enterocolitis caused by toxigenic *Clostridium difficile*, following alteration of the intestinal microflora. Previous use of antimicrobials, especially ampicillin, cefalosporins and clindamycin, is often implicated. Treatment with any suspect antimicrobial should be ceased immediately. If toxigenic *C. difficile* is proven or suspected, treatment should be initiated promptly.

7.9.5 Comments

Patients who fail to respond to treatment with metronidazole should receive vancomycin 125 mg (children: 5mg/kg; maximum 125mg) orally every 6 hours for 7–14 days.

7.10 Non-diarrheal gastrointestinal infections

7.10.1 Acute gastritis and peptic ulcer disease

Acute gastritis and peptic ulcer disease are commonly associated with infection of the mucosa of the upper gastrointestinal tract with *Helicobacter pylori*. If possible, presence of the organism should be confirmed by biopsy (for bacterial culture) or by a positive breath test (for ketones). Various treatment regimens have been used, of which the following options are suggested based on their efficacy, simplicity and availability. Only adult doses are described, as the condition is not usually found in children. Both regimens are associated with a 80–85% clearance rate.

7.10.1 Treatment

Bismuth salicylate 107.7 mg (1 tablet) orally every 6 hours for 2 weeks *plus* metronidazole 200 mg orally every 8 hours and 400 mg orally at night for 2 weeks (contraindicated during pregnancy) *plus either* tetracycline 500mg orally every 6 hours for 2 weeks (contraindicated during pregnancy) *or*amoxicillin 500 mg orally every 6 hours for 2 weeks. Alternative regi*men.*
Omeprazole 40mg orally every 24 hours for 2 weeks *plus* metronidazole 400 mg orally every 8 hours for 2 weeks (contraindicated during pregnancy) *plus*amoxicillin 500 mg orally every 8 hours for 2 weeks.

7.10.2 Acute cholecystitis

Acute cholecystitis is often associated with obstruction by calculi. The infecting organisms are predominantly ascending bowel flora, especially *Escherichia coli* and *Klebsiella* spp. Sudden onset of pyrexia, often with rigors, and pain and tenderness in the right upper quadrant are
characteristic. Jaundice is often an accompanying sign. Immediate surgery is required for gangrenous cholecystitis, associated perforation and abscess formation.

7.10.3 Treatment

Ampicillin 1–2 g (children: 25–50mg/kg; maximum 2g) i.v. or i.m. every 6 hours for up to 7 days *plus* gentamicin 5–7mg/kg i.v. daily in divided doses (children: 7.5mg/kg i.v. in 1–3 divided doses daily) for up to 7 days (contraindicated during pregnancy).

7.10.4 Acute peritonitis

Intra-abdominal sepsis may develop either as a result of an external injury (e.g. a stab wound), a ruptured intra-abdominal organ (e.g. appendicitis) or postoperatively following abdominal or pelvic surgery. Typically, the involved pathogens are the patient's own bowel flora (aerobes and anaerobes). Severe pain, vomiting and pyrexia are common. Other signs include rigidity,
rebound tenderness and absent bowel sounds.

7.10.5 Treatment

Ampicillin 2g (children: 50mg/kg; maximum 2g) i.v. or i.m. every 6 hours for at least 7 days *plus* gentamicin 5–7mg/kg i.v. daily in divided doses (children:7.5mg/kg i.v. in 1–3 divided doses daily) for at least 7 days (contraindicated during pregnancy) *plus* metronidazole 500mg

(children: 12.5mg/kg; maximum 500 mg) i.v. every 8–12 hours for at least 7 days (contraindicated during pregnancy). For patients who are allergic to penicillins, ampicillin should be deleted from the above regimen.
This study converts knowledge of gastrointestinal tract infections in the form of probability tables, which describes the evidence of certain disease against some specific symptoms. Also certainty factor table to handle fuzziness.

8 Bacterial Infection Symptom Table

Below Is the Table which describe the evidence of diseases like vomiting, fever, diarrhea against bacteria. The evidence is describe in terms of' +' sign and if a particular disease is not cause by listed bacteria, it is denoted in the table by ' – 'sign.

Table 1: Bacterial Infection Symptom

CLINICAL FEATURES OF BACTERIAL DIARRHEAL DISEASE				
Pathogen	Symptoms			
	Diarrhea	Vomiting	Abd Crams	Fever
Salmonella	++	+	-	+
Campylobacter	+++	-	++	++
Shigella	++/+++'	-	+	+
Vibrio Cholerea	++++	+	-	-
Vibrio Parahaemolytious	+/++	+	+	+
Clostridium perfingens	++	-	++	-
Bacillus Cereus Diarrheal	++	-	++	-
Bacillus Cereus Emetic	+	++	-	-
Yersinia Enterocolitica	++	-	++	+

9 Certainty Factor Table:

This table is designed to control Fuzziness. We have assigned certain limits to appropriate degree (severe, high, low absent) based on knowledge acquired from experts.

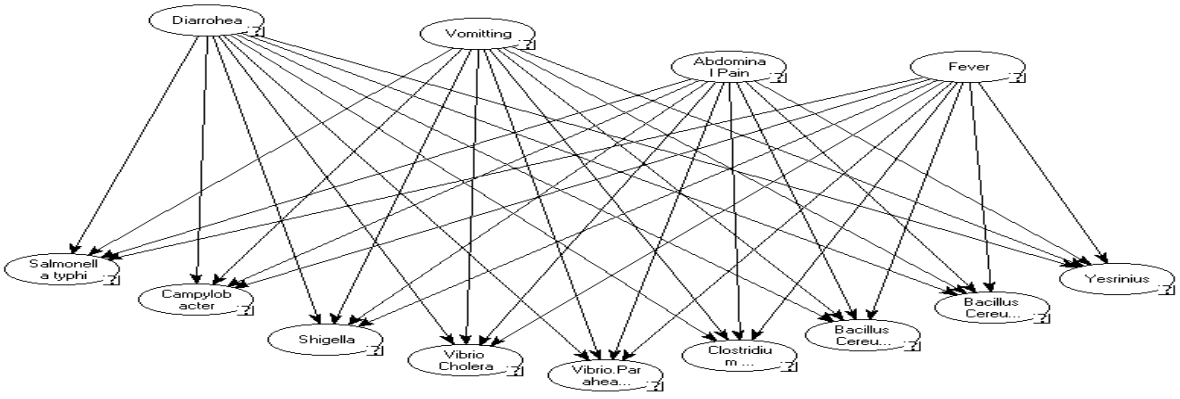
Table 2 : Certainty Factor to control Fuzziness

Symptom	**Degree**	**Certainty Factor**
Diarrhea	Severe	0.5
	High	0.3
	Moderate	0.15
	Low	0.05
Vomiting	High	0.6
	Low	0.3
	Absent	0.1
Abdominal Pain	High	0.6
	Low	0.3
	Absent	0.1
Fever	High	0.6
	Low	0.3
	Absent	0.1

10 Belief Network Development

Following is the graphical representation of the Belief network which we have developed through graphical part of GeNIe. This network is used by MES for reasoning through the Inference part of GeNIe called SIMLE.This network diagram is a **DAG** (directed a-cyclic Graph) consists of node and directed links. Node defines the diseases and bacterial Infections. Each node has been assigned probabilities which are hidden in graphical representation, but used in the reasoning process by SMILE. Belief Network is supposed to be the best technology where variable are not best to be known with their discrete amount.

Fig 3 Belief Network of Gastrointestinal tract infections



11 Summary and Concluding Remarks

Knowledge representation has different techniques, probabilistic reasoning and fuzzy logic is one of the used in this study. This approach converts knowledge of GIT infections in the form of probability tables, which describes the evidence of certain disease against some specific symptoms. Besides constructing probability table, also designed certainty factor table to handle fuzziness.

References:

[1]. Althoff, K., S. Wess, and M. Manago, 1994, "Reasoning with Cases-Theory and Practice", Proceedings of the European Conference on Artificial Intelligence, pp. 1-26.
[2]. Bramer, M., 1989, "Ch3. Expert systems: where are we and where are we going?", In Forsyth, R., (eds), 1989, EXPERT SYSTEMS: Principles and case studies, 2nd Ed, Chapman and Hall Ltd, pp. 31-53.
[3]. Carrico, M. A., J. C. Girard, and J. P. Jones, 1989, Building knowledge systems, McGraw-Hill Book Co., New York.
[4]. Chadwick, M. and J.A. Hannah, 1986, Expert Systems for Personal Computers - An Introduction to Artificial Intelligence, Sigma Press, Wilmslow, England, Chapter 2: Principles of Rule-based Expert Systems, pp.9-29.
[5]. Chris, N, 1997, "Appendix C: PROLOG and Expert System Products", Expert Systems: Introduction to First and Second Generation and Hybrid Knowledge Based Systems, Marcel Dekker, Inc., New York, pp.317-326.
[6]. Environmental Systems Research Institute, 1999, ESRI MapObjectsTM Version 2.0, Environmental Systems Research Institute, Inc.
[7]. Schank, R., 1982, Dynamic Memory: A Theory of Learning in Computers and People, Cambridge University Press.
[8]. Shortliffe, E., 1976, Computer-Based Medical Consultations: MYCIN, American Elsevier Co., New York.
[9]. Wilson, P.A., 1997, "Rule-Based Classification of Water in Landsat MSS Images Using the Variance Filter", Photogrammetric Engineering and Remote Sensing, Vol. 63, No. 5, pp.485-491.
[10]. Winston, P.H., 1984, Artificial Intelligence, 2nd Ed., Addison-Wesley publishing Co.