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Emergency scenario similarity measures in emergency rescue planning based on intuitionistic fuzzy sets

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Abstract

These years, emergency management is a research hotspot in System engineering. This paper aims to develop a decision-making tool that can be used by government agencies in emergency rescue, when they need to match present situation to one of the fittest scenario described in emergency plan. As clear disaster date in emergency rescue could hardly be gotten, we study the scenario matching with uncertain data IFSs. Intuitionistic fuzzy sets (IFSs), proposed by Atanassov, have gained attention from researchers for their applications in various fields, IFSs data is easier to get and fit for emergency rescue.

Keywords: system engineering, emergency rescue planning, scenario, similarity measure, intuitionistic fuzzy sets;

1. Introduction

These years there has occurred many severe disasters, such as 911 attacks in 2011, 2004 Indian Ocean tsunami, Hurricane Katrina in the United States in 2005, Kuril Islands earthquake in 2006, snowstorm in southern China in early 2008, 12 May 2008 Wenchuan earthquake, Haiti earthquake in 2010, Japan nuclear leak in 2011, Wenzhou railway accident in 2011, etc. These disasters all cause huge property damage and human injuries.

A suitable emergency rescue planning will give a great help in emergency rescue. And an excellent emergency planning usually consider many scenarios so that it could fit for many conditions when a disaster occurred. Time is the most important character in disaster rescue, so it is important to quickly and accurately identification the current scenario and match it to one of the scenario in the emergency planning, and select the proper rescue strategy according the scenario.

Different to many studies that uses stochastic programming models, we discuss the case that the data is Intuitionistic fuzzy sets (IFSs) data , which is more easy to get.

2. Literature review

2.1 Scenario methods

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For any planning concern to future, it has to face to a difficult problem – what future would be, Such as future Business competition, GDP (Gross Domestic Product), future CPI (Consumer Price Index), PMI (Purchase Management Index), Fiscal policy, interest rates, etc. Future is generally described by predictions, but the prediction is very difficult to be accurate, such as Asia Bank predict that China's 2011 GDP growth is 9.6 at the begin of this year, but predit it down to 9.3% on 2011-09-14 [1].

Both professional planners and individuals preparing for a better future is not the tangibles , best method is scenarios -- to visualize different kinds of futures adequately capture these intangibles.

The definition of scenario in dictionary is [2]:

1) An outline or synopsis of a play (or, by extension, of a literary work).
2) A setting for a work of art or literature; "the scenario is France during the Reign of Terror".
3) A postulated sequence of possible events; "planners developed several scenarios in case of an attack".
4) A preliminary sketch of the plot, or main incidents, of an opera.

Peter Schwartz [3]gives a detailed definition: scenarios is a tool for ordering one's perceptions about alternative future environments in which one's decisions might be played out. Alternatively: a set of organized ways for us to dream effectively about our own future.

Scenario planning is a process of positing several informed, plausible and imagined alternative future environments in which decisions about the future may be played out, for the purpose of changing current thinking, improving decision making, enhancing human and organization learning and improving performance [4].

Scenario planning is a tool that has gained increased attention during the last 20 years as an effective method for examining future uncertainties and investigating assumptions in organizations. Peter[5] point out that "scenarios are not predictions.", it represent instead, possible alternative dimensions of the future that reflect the driving forces of that future. Fig 1 shows the conceptual model [6].

Scenario planning is wide ranging and includes in many areas [7], such as, crisis management, scientific community, public policy making, professional futurist institutes, educational institutes, businesses, etc.

Scenario method was used widely in disaster management study. Nezih [8] statistics OR/MS research in disaster operations management (DOM) articles, find that47.6% papers cover man-made emergencies and 40.5% papers cover general approaches to disaster operations management designed to apply to all disaster situations, in contrast to the scenario based disaster and emergency management plans used by government agencies.

Michael[9] point out that Atmospheric and hydrological aspects of a hypothetical storm scenario have been quantified as a basis for estimation of human, infrastructure, economic, and environmental impacts for emergency-preparedness and flood-planning exercises.

Mei-Shiang [10] describe the scenario with the decision variables include the structure of rescue organizations, locations of rescue resource storehouses, allocations of rescue resources under capacity restrictions, and distributions of rescue resources. And their study deals the flood emergency logistics problem with uncertainty that is formulated as two stochastic programming models.

In order to generate demand scenarios, a Markov chain associated with hurricane countrates is assumed by Selda [11]. Ansal [12] uses Deterministic hazard scenarios and time-dependent probabilistic hazard assessment as input to a GIS-based loss estimation model, to evaluate the earthquake risk for Istanbul.

2.2 Intuitionistic fuzzy sets (IFSs) and similarity measure with IFSs

Intuitionistic fuzzy sets (IFSs) proposed by Atanassov [13, 14,15] have been found to be highly useful to deal with vagueness. Szmidt and Kacprzyk[16], Grzegorzewski[17], Wang and Xin[18] proposed distance measures between IFSs, based on the geometric interpretation of intuitionistic fuzzy sets. Li and Cheng[19] proposed four properties of IFSs similarity measures, Wang and Xin[20] proposed four properties of IFSs distance measures. Song [21] proposes a new property of distance measure on IFSs.

Definition 2.1 Zadeh[22]. A fuzzy set A in $X = \{x\}$ is given by $A=\{<x, \mu_A(x)>|x \in X\}$, where $\mu_A(x)$: $x \rightarrow [0, 1]$ is the membership function of the fuzzy set A: $\mu_A(x) \in [0, 1]$ is the membership degree of $x \in X$ in A.

Definition 2.2 Atanassov [13]. An intuitionistic fuzzy set A in X is given by $A = \{<x, \mu_A(x), \nu_A(x)>, x \in X\}$, where $\mu_A(x)$: $x \rightarrow [0, 1]$,$\nu_A(x)$: $x \rightarrow [0, 1]$