Performance analysis on algorithms for selection of desired healthcare services

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Summary In recent years, there has been a tremendous growth in healthcare services. Different hospitals with the support of many specialists provide a wide variety of healthcare services. The information about different hospitals and their health care service capabilities are quite not well integrated. However, IT based solutions are being developed for effective sharing of health care service capabilities and for selection of desired health care service providers. As different hospitals provide a wide variety of health care services and since different users have different criteria in selecting the health care providers, the selection of health care providers can be modelled as a multi-criteria decision making problem. In this paper, attempts were made to apply different multi-criteria solution methodologies such as ELECTRE, PROMETHEE, AHP for health care service applications. The algorithms were implemented and their performance were analyzed and investigated. The experimental results prove that the PROMETHEE method is best suited for solving multi-criteria decision making problem in the selection of desired health care services.

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Introduction

The tremendous development in the healthcare services has ensured the inevitable role of information technology in providing suitable healthcare service. There are many healthcare service providers which provide similar healthcare services with difference in criteria such as hospital facilities, cost, location, etc. The selection of the healthcare services is also greatly influenced by the patients'...
preferences. Selection of the best healthcare service, during the
time of health crisis is a difficult task due to the influence
of different criteria and also the patients’ preferences. The
selection of the best health care service based on patients’
preferences can be modelled as a multi-criteria problem.
In this paper, we have applied the multi-criteria solution
methodologies such as ELECTRE, PROMETHEE and AHP for
selecting health care services. The best suited selection
methodology is measured in terms of (i) the average over-
head, (ii) the time taken to select the health care services,
(iii) degree of human intervention and (iv) patient satisfac-
tion. The experimental results show that PROMETHEE is best
suited for healthcare applications.

Related work
Some of the available service selection schemes are con-
sumer centric QoS-aware fuzzy selection (Lin et al., 2008),
search-based QoS ranking prediction (Mao et al., 2015) and
fuzzy framework (Chouiref et al., 2016).
Mao et al. (2015) proposed a search-based QoS ranking
prediction and particle swarm optimization for cloud envi-
ronments. Chouiref et al. (2016) proposed a fuzzy framework
for service selection. Lin et al. (2008) proposed consumer
centric QoS-aware fuzzy web service selection.
Recently, many multi-criteria methodologies such as
PROMETHEE, ELECTRE and AHP are applied to select the
best suitable alternatives. PROMETHEE (Behzadian et al.,
2010; Silas et al., 2013; Mircea et al., 2016) is one of the
outranking techniques that work on pair wise comparisons.
PROMETHEE I performs partial ranking and PROMETHEE II
performs complete ranking. PROMETHEE II is well suited to
solve NP problems. PROMETHEE calculates the net ranking
based on positive and negative ranking of every feasible
service. ELECTRE (Silas et al., 2012; Figueria et al., 2013;
Doumpos et al., 2014) is another outranking technique that
also works on pair wise comparisons. Among many variations
of ELECTRE, ELECTRE III is suitable for finding outranking
relations.
Analytic Hierarchy Process (AHP) (Francis and Rajsingh,
2010; Pettrini et al., 2016; Yagmur, 2016) is a multi-criteria
decision making technique. AHP assigns weight for every
criteria based on the preference. Then AHP computes the
vector of criteria weights based on the concept of eigen
vectors. The final ranking is obtained by performing a con-
sistency check.

Performance analysis on algorithms
In this section, the algorithms of AHP, ELECTRE, PROMETHEE
were implemented for healthcare service application and
their performance in terms of (i) the average overhead
incurred in selection of the healthcare services, (ii) the
time taken to select the health care services, (iii) degree
of human intervention and (iv) patient satisfaction based on
the overall performance were investigated.

Analysis on overhead
The overhead required to detect the best healthcare as
required by the patient using the three methodologies were
determined for different number of healthcare providers
and is shown in Fig. 1. The number of preferences was main-
tained as 10 for all the methodologies.

It is evident from the graph that the overhead incurred to
select the best health care provider is less for PROMETHEE
when compared to AHP and ELECTRE, even with higher num-
ber of healthcare providers.

Analysis on service selection time
The service selection time taken to detect the best health
care as required by the patient using the three methodolo-
gies were determined for different number of health care
providers having same number of preferences and is shown
in Fig. 2. The experimental results show that the service
selection time for PROMETHEE is of the order of 5–15 ms
and it is much lower compared to AHP and ELECTRE.

Analysis on degree of human intervention
The degree of human intervention while using the AHP,
ELECTRE, and PROMETHEE for healthcare service applica-
tion was investigated and the results are shown in Fig. 3.
The results show that PROMETHEE requires lesser degree of human intervention compared to AHP and ELECTRE, thereby providing an obvious choice for using it for healthcare applications.

Analysis on overall performance

The overall performance of the AHP, ELECTRE and PROMETHEE were evaluated by obtaining the patient and user feedback on the satisfaction level of utilising the services using different methodologies. The feedback as shown in Fig. 4, implies that the 95% of the users expressed excellent satisfaction while using PROMETHEE algorithm for healthcare service selection application.

Conclusion

In this paper, different multi-criteria methodologies such as AHP, ELECTRE, and PROMETHEE were investigated for healthcare service application. They were investigated in terms of (i) the average overhead incurred in selection of the health care services, (ii) the time taken to select the health care services, (iii) degree of human intervention and (iv) patient satisfaction based on the overall performance. All the investigations reveal that PROMETHEE is best suited for healthcare service application.

Conflict of interest

There is no conflict of interest to declare.

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References


