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ON SOFT EXPERT SETS

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Abstract – Alkhazaleh and Salleh defined the concept of soft expert sets [Advances in Decision Sciences, Article ID 757868, 2011]. In this paper, we make some modification to the soft expert sets. On the modified soft expert sets we then construct a decision making method which selects an elements from the alternatives. We finally give an example to shows this method can be successfully applied to some many uncertainty problems.

Keywords – *Soft sets, soft expert sets, soft operations, decision making.*

1 Introduction

The concept of soft sets was first introduced by Molodtsov [14]. Until now many versions of it have been developed and applied to a lot of areas from algebra to decision making problems. One of these versions is soft expert sets introduced by Alkhazaleh and Salleh [5]. They also propounded fuzzy soft expert sets [6] by using soft expert sets and fuzzy soft sets [12]. Afterwards, Hazaymeh et al. [9] improved generalized fuzzy soft expert sets. Then, Alhazaymeh and Hassan [1, 2] developed generalized vague soft expert (*gvse*) sets and gave an application of them in decision making. They also studied mapping on *gvse*-sets [3].

Although the concept of soft expert sets is important for the development of soft sets, it has some own difficulties arising from some definitions. This situation necessitates to arrange some parts of it. For example, although the idea based on the principle of time-dependent change of the experts' opinion is impressive, this scenario has not been modelled by using adequate parameterizations in [5]. So, we will ignore this idea for the time being. In addition to this case, we should emphasize that the soft expert sets have become consistent in itself. In other words, some arranges can be necessary when the other types of soft expert sets, as fuzzy parameterized soft expert sets [7] and fuzzy parameterized fuzzy soft expert sets [10], are taken into consideration.

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2 Soft Expert Sets

In this section, we recall some basic notions with some remarks and updates in soft expert sets [5]. Let U be a universe, E be a set of parameters, X be a set of experts (agents), $O = \{0, 1\}$ be a set of opinions, $Z = E \times X \times O$ and $A \subseteq Z$.

Definition 2.1. A pair (F, A) is called a soft expert set over U, where F is a mapping given by

$$F : A \to P(U)$$

where $P(U)$ denotes the power set of U.

Example 2.2. Suppose that a company produces some new products and wants to obtain the opinion of some experts about these products. Let $U = \{u_1, u_2, u_3, u_4\}$ be a set of products, $E = \{e_1, e_2, e_3\}$ be a set of decision parameters where e_i ($i \in \{1, 2, 3\}$) denotes the parameters as *easy to use*, *quality* and *cheap*, respectively, and let $X = \{p, q, r\}$ be a set of experts.

Assume that the company has distributed a questionnaire to three experts to make decisions on the products, and the results of this questionnaire are as in the following,

$$\begin{array}{lll}
F(e_1,p,1) = \{u_1,u_2,u_4\}, & F(e_1,q,1) = \{u_1,u_4\}, & F(e_1,r,1) = \{u_3,u_4\}, \\
F(e_2,p,1) = \{u_4\}, & F(e_2,q,1) = \{u_1,u_3\}, & F(e_2,r,1) = \{u_1,u_2,u_4\}, \\
F(e_3,p,1) = \{u_3,u_4\}, & F(e_3,q,1) = \{u_1,u_2\}, & F(e_3,r,1) = \{u_4\}, \\
F(e_1,p,0) = \{u_3\}, & F(e_1,q,0) = \{u_2,u_3\}, & F(e_1,r,0) = \{u_1,u_2\}, \\
F(e_2,p,0) = \{u_1,u_2,u_3\}, & F(e_2,q,0) = \{u_2,u_4\}, & F(e_2,r,0) = \{u_3\}, \\
F(e_3,p,0) = \{u_1,u_2\}, & F(e_3,q,0) = \{u_3,u_4\}, & F(e_3,r,0) = \{u_1,u_2,u_3\}
\end{array}$$

Then the soft expert set (F, Z) as in the following,

$$\begin{aligned}
(F,Z) = \; & \{((e_1,p,1),\{u_1,u_2,u_4\}),((e_1,q,1),\{u_1,u_4\}),((e_1,r,1),\{u_3,u_4\}), \\
& ((e_2,p,1),\{u_4\}),((e_2,q,1),\{u_1,u_3\}),((e_2,r,1),\{u_1,u_2,u_4\}), \\
& ((e_3,p,1),\{u_3,u_4\}),((e_3,q,1),\{u_1,u_2\}),((e_3,r,1),\{u_4\}), \\
& ((e_1,p,0),\{u_3\}),((e_1,q,0),\{u_2,u_3\}),((e_1,r,0),\{u_1,u_2\}), \\
& ((e_2,p,0),\{u_1,u_2,u_3\}),((e_2,q,0),\{u_2,u_4\}),((e_2,r,0),\{u_3\}), \\
& ((e_3,p,0),\{u_1,u_2\}),((e_3,q,0),\{u_3,u_4\}),((e_3,r,0),\{u_1,u_2,u_3\})\}
\end{aligned}$$

In this example, the expert p agrees that *easy to use* products are u_1, u_2 and u_4. The expert q agrees that the *easy to use* products are u_1 and u_4, and the expert r agrees that the *easy to use* products are u_3 and u_4. Notice also that all of them agree that product u_4 is *easy to use.*

Remark 2.3. In a soft set, for the parameter e_1, $F(e_1)$ and $G(e_1)$ can be different since the functions F and G may be different. However, in a soft expert set, for the parameter $(e_1, p, 1)$, $F(e_1, p, 1)$ and $G(e_1, p, 1)$ have to be the same since any variable causing changes, such as time, in the choices of expert p does not exist. In other words, for $t_1 \neq t_2$, $F(e_1, p, 1, t_1)$ and $G(e_1, p, 1, t_2)$ can be different.

From now on, since an expert p can not claim that a product either provides or does not provide the parameter in the same time, all of the examples given in [5] have been updates.

Definition 2.4. For two soft expert sets (F, A) and (G, B) over U, (F, A) is called a soft expert subset of (G, B), denoted by $(F, A)\tilde{\subseteq}(G, B)$, if $F(\alpha) \subseteq G(\alpha)$, for all $\alpha \in A$.

If $(F, A)\tilde{\subseteq}(G, B)$, then (G, B) is called a soft expert superset of (F, A).

Proposition 2.5. Let (F, A) and (G, B) be two soft expert sets over U. Then

$$(F, A)\tilde{\subseteq}(G, B) \Leftrightarrow (F, A) \subseteq (G, B) \Leftrightarrow A \subseteq B$$

Definition 2.6. Two soft expert sets (F, A) and (G, B) over U are said to be equal if $(F, A)\tilde{\subseteq}(G, B)$ and $(G, B)\tilde{\subseteq}(F, A)$.

Proposition 2.7. Let (F, A) and (G, B) be two soft expert sets over U. Then

$$(F, A) = (G, B) \Leftrightarrow A = B$$

Example 2.8. Let

$$\begin{aligned} (F, A) = \ & \{((e_1, p, 1), \{u_1, u_2, u_4\}), ((e_1, q, 1), \{u_1, u_4\}), ((e_2, q, 1), \{u_1, u_3\}), \\ & ((e_2, r, 1), \{u_1, u_2, u_4\}), ((e_3, p, 1), \{u_3, u_4\}), ((e_3, r, 1), \{u_4\}), \\ & ((e_1, r, 0), \{u_1, u_2\}), ((e_2, p, 0), \{u_1, u_2, u_3\}), ((e_3, q, 0), \{u_3, u_4\})\} \end{aligned}$$

and

$$\begin{aligned} (G, B) = \ & \{((e_1, p, 1), \{u_1, u_2, u_4\}), ((e_1, q, 1), \{u_1, u_4\}), ((e_2, q, 1), \{u_1, u_3\}), \\ & ((e_2, r, 1), \{u_1, u_2, u_4\}), ((e_1, r, 0), \{u_1, u_2\}), ((e_2, p, 0), \{u_1, u_2, u_3\})\} \end{aligned}$$

Therefore $(G, B)\tilde{\subseteq}(F, A)$. Clearly $B \subseteq A$.

Definition 2.9. An agree-soft expert set $(F, A)_1$ which is also a soft expert subset of (F, A) over U is defined as in the following,

$$(F, A)_1 = \{(\alpha, F(\alpha)) : \alpha \in A_1\}$$

where, $A_1 \subseteq Z_1$ such that $Z_1 := E \times X \times \{1\}$.

Example 2.10. Let's consider Example 2.2. Then

$$\begin{aligned} (F, Z)_1 = \ & \{((e_1, p, 1), \{u_1, u_2, u_4\}), ((e_1, q, 1), \{u_1, u_4\}), ((e_1, r, 1), \{u_3, u_4\}), \\ & ((e_2, p, 1), \{u_4\}), ((e_2, q, 1), \{u_1, u_3\}), ((e_2, r, 1), \{u_1, u_2, u_4\}), \\ & ((e_3, p, 1), \{u_3, u_4\}), ((e_3, q, 1), \{u_1, u_2\}), ((e_3, r, 1), \{u_4\})\} \end{aligned}$$

Definition 2.11. A disagree-soft expert set $(F,A)_0$ which is a soft expert subset of (F,A) over U is defined as in the following,

$$(F,A)_0 = \{(\alpha, F(\alpha)) : \alpha \in A_0\}$$

where, $A_0 \subseteq Z_0$ such that $Z_0 := E \times X \times \{0\}$.

Example 2.12. Let's consider Example 2.2. Then

$$\begin{aligned}(F,Z)_0 = \; & \{((e_1,p,0),\{u_3\}),((e_1,q,0),\{u_2,u_3\}),((e_1,r,0),\{u_1,u_2\}),\\ & ((e_2,p,0),\{u_1,u_2,u_3\}),((e_2,q,0),\{u_2,u_4\}),((e_2,r,0),\{u_3\}),\\ & ((e_3,p,0),\{u_1,u_2\}),((e_3,q,0),\{u_3,u_4\}),((e_3,r,0),\{u_1,u_2,u_3\})\}\end{aligned}$$

Remark 2.13. According to the definition of soft expert sets given in [5], it has been studied over a subset of the parameter set Z. However, from the definition of 'not α' and 'NOT Z', defined by $\neg\alpha = (\neg e_i, x_j, o_k)$ and $\rceil Z = \{\neg\alpha : \alpha \in Z\}$, respectively, $\rceil Z \nsubseteq Z$.

On the other hand, $\rceil A_1 \subseteq \rceil Z_1$. That is, $\rceil A_1 \subseteq \rceil E \times X \times \{1\}$. Since, $\rceil A_1 \neq A_0$, the propositions given in [5]

ii. $(F,A)_1^{\tilde{c}} = (F,A)_0$

iii. $(F,A)_0^{\tilde{c}} = (F,A)_1$

are not held according to the definition of equality of two soft expert sets in [5]. It can be overcome this kind of difficulties by accepting as $(\neg e_1, p, 1) = (e_1, p, 0)$. So, $\rceil Z_1 = Z_0$. In other words, the propositions

ii. $(F,Z)_1^{\tilde{c}} = (F,Z)_0$

iii. $(F,Z)_0^{\tilde{c}} = (F,Z)_1$

are held.

In the view of such information, the definition of *not set* and *soft expert complement* can be rewritten as in the following,

Definition 2.14. Let $\alpha = (e_i, x_j, o_k) \in Z$. Then *not* α and *NOT* Z are defined by $\neg\alpha = (e_i, x_j, 1 - o_k)$ and $\rceil Z = \{\neg\alpha : \alpha \in Z\}$, respectively. It can easily be seen that $\rceil Z = Z$ but $\rceil A \neq A$, for some $A \subseteq Z$.

Definition 2.15. The complement of a soft expert set (F,A) is denoted by $(F,A)^{\tilde{c}}$ and is defined by $(F,A)^{\tilde{c}} = (F^{\tilde{c}}, \rceil A)$ where $F^{\tilde{c}} : \rceil A \to P(U)$ is mapping given by $F^{\tilde{c}}(\neg\alpha) = U - F(\alpha)$, for all $\neg\alpha \in \rceil A$.

Proposition 2.16. Let (F,A) be a soft expert set over U. Then $((F,A)^{\tilde{c}})^{\tilde{c}} = (F,A)$.

Example 2.17. Let's consider Example 2.2. Then

$$\begin{aligned}(F,Z)^{\tilde{c}} = \; & \{((e_1,p,0),\{u_3\}),((e_1,q,0),\{u_2,u_3\}),((e_1,r,0),\{u_1,u_2\}),\\ & ((e_2,p,0),\{u_1,u_2,u_3\}),((e_2,q,0),\{u_2,u_4\}),((e_2,r,0),\{u_3\}),\\ & ((e_3,p,0),\{u_1,u_2\}),((e_3,q,0),\{u_3,u_4\}),((e_3,r,0),\{u_1,u_2,u_3\}),\\ & ((e_1,p,1),\{u_1,u_2,u_4\}),((e_1,q,1),\{u_1,u_4\}),((e_1,r,1),\{u_3,u_4\}),\\ & ((e_2,p,1),\{u_4\}),((e_2,q,1),\{u_1,u_3\}),((e_2,r,1),\{u_1,u_2,u_4\}),\\ & ((e_3,p,1),\{u_3,u_4\}),((e_3,q,1),\{u_1,u_2\}),((e_3,r,1),\{u_4\})\} = (F,Z)\end{aligned}$$

Definition 2.18. The union of two soft expert sets (F,A) and (G,B) over U, denoted by $(F,A)\widetilde{\cup}(G,B)$, is the soft expert set (H,C) where $C = A \cup B$, and for all $\alpha \in C$,

$$H(\alpha) = \begin{cases} F(\alpha), & \alpha \in A - B,\\ G(\alpha), & \alpha \in B - A,\\ F(\alpha) = G(\alpha), & \alpha \in A \cap B.\end{cases}$$

Proposition 2.19. Let (F,A) and (G,B) be two soft expert sets over U. Then

$$(F,A)\widetilde{\cup}(G,B) = (F,A) \cup (G,B)$$

Example 2.20. Let

$$\begin{aligned}(F,A) = \; & \{((e_1,p,1),\{u_1,u_2,u_4\}),((e_1,q,1),\{u_1,u_4\}),((e_2,q,1),\{u_1,u_3\}),\\ & ((e_2,r,1),\{u_1,u_2,u_4\}),((e_3,p,1),\{u_3,u_4\}),((e_3,r,1),\{u_4\}),\\ & ((e_1,r,0),\{u_1,u_2\}),((e_2,p,0),\{u_1,u_2,u_3\}),((e_3,q,0),\{u_3,u_4\})\}\end{aligned}$$

and

$$\begin{aligned}(G,B) = \; & \{((e_1,p,1),\{u_1,u_2,u_4\}),((e_1,q,1),\{u_1,u_4\}),((e_2,q,1),\{u_1,u_3\}),\\ & ((e_2,r,1),\{u_1,u_2,u_4\}),((e_3,q,1),\{u_1,u_2\}),((e_1,r,0),\{u_1,u_2\}),\\ & ((e_2,p,0),\{u_1,u_2,u_3\}),((e_3,p,0),\{u_1,u_2\})\end{aligned}$$

Then

$$\begin{aligned}(F,A)\widetilde{\cup}(G,B) = \; & \{((e_1,p,1),\{u_1,u_2,u_4\}),((e_1,q,1),\{u_1,u_4\}),((e_2,q,1),\{u_1,u_3\}),\\ & ((e_2,r,1),\{u_1,u_2,u_4\}),((e_3,p,1),\{u_3,u_4\}),((e_3,q,1),\{u_1,u_2\}),\\ & ((e_3,r,1),\{u_4\}),((e_1,r,0),\{u_1,u_2\}),((e_2,p,0),\{u_1,u_2,u_3\}),\\ & ((e_3,p,0),\{u_1,u_2\}),((e_3,q,0),\{u_3,u_4\})\}\end{aligned}$$

Proposition 2.21. Let (F, A), (G, B) and (H, C) be three soft expert sets over U. Then

i. $(F, A)\widetilde{\cup}(F, A) = (F, A)$

ii. $(F, A)\widetilde{\cup}(G, B) = (G, B)\widetilde{\cup}(F, A)$

iii. $(F, A)\widetilde{\cup}((G, B)\widetilde{\cup}(H, C)) = ((F, A)\widetilde{\cup}(G, B))\widetilde{\cup}(H, C)$

Remark 2.22. For all $\alpha \in A \cap B$, $F(\alpha) = G(\alpha)$. That is, $(F, A)\widetilde{\cup}(G, B)=(F, A)\widetilde{\cap}(G, B)$ in [5]. Therefore, for the intersection of two soft expert sets (H, C), the set C may consider as $A \cap B$.

Definition 2.23. The intersection of two soft expert sets (F, A) and (G, B) over U, denoted by $(F, A)\widetilde{\cap}(G, B)$ is the soft expert set (H, C) where $C = A \cap B$, for all $\alpha \in C$, and

$$H(\alpha) = \begin{cases} F(\alpha) = G(\alpha), & if\ C \neq \emptyset \\ \emptyset, & otherwise \end{cases}$$

Proposition 2.24. Let (F, A) and (G, B) be two soft expert sets over U. Then

$$(F, A)\widetilde{\cap}(G, B) = (F, A) \cap (G, B)$$

Example 2.25. Let's consider the Example 2.17. Then

$$\begin{aligned} (F, A)\widetilde{\cap}(G, B) = \; & \{((e_1, p, 1), \{u_1, u_2, u_4\}), ((e_1, q, 1), \{u_1, u_4\}), ((e_2, q, 1), \{u_1, u_3\}), \\ & ((e_2, r, 1), \{u_1, u_2, u_4\}), ((e_1, r, 0), \{u_1, u_2\}), ((e_2, p, 0), \{u_1, u_2, u_3\})\} \end{aligned}$$

Proposition 2.26. Let (F, A), (G, B) and (H, C) be three soft expert sets over U. Then

i. $(F, A)\widetilde{\cap}(F, A) = (F, A)$

ii. $(F, A)\widetilde{\cap}(G, B) = (G, B)\widetilde{\cap}(F, A)$

iii. $(F, A)\widetilde{\cap}((G, B)\widetilde{\cap}(H, C)) = ((F, A)\widetilde{\cap}(G, B))\widetilde{\cap}(H, C)$

Proposition 2.27. Let (F, A), (G, B) and (H, C) be three soft expert sets over U. Then

i. $(F, A)\widetilde{\cup}((G, B)\widetilde{\cap}(H, C)) = ((F, A)\widetilde{\cup}(G, B))\widetilde{\cap}((F, A)\widetilde{\cup}(H, C))$

ii. $(F, A)\widetilde{\cap}((G, B)\widetilde{\cup}(H, C)) = ((F, A)\widetilde{\cap}(G, B))\widetilde{\cup}((F, A)\widetilde{\cap}(H, C))$

Definition 2.28. Let (F, A) and (G, B) be two soft expert sets over U. Then (F, A) AND (G, B), denoted by $(F, A) \wedge (G, B)$, is defined by

$$(F, A) \wedge (G, B) = (H, A \times B)$$

where $H(\alpha, \beta) = F(\alpha) \cap G(\beta)$, for all $(\alpha, \beta) \in A \times B$.

Definition 2.29. Let (F, A) and (G, B) be two soft expert sets over U. Then (F, A) OR (G, B), denoted by $(F, A) \vee (G, B)$, is defined by

$$(F, A) \vee (G, B) = (O, A \times B)$$

where $O(\alpha, \beta) = F(\alpha) \cup G(\beta)$, for all $(\alpha, \beta) \in A \times B$.

Example 2.30. Let

$$\begin{aligned}(F,A)= \; & \{((e_2,q,1),\{u_1,u_3\}),((e_3,p,1),\{u_3,u_4\}),((e_3,r,1),\{u_4\}),\\ & ((e_1,r,0),\{u_1,u_2\}),((e_3,q,0),\{u_3,u_4\})\}\end{aligned}$$

and

$$(G,B)= \; \{((e_1,q,1),\{u_1,u_4\}),((e_2,q,1),\{u_1,u_3\}),((e_2,r,1),\{u_1,u_2,u_4\})\}$$

Then

$$\begin{aligned}(F,A)\wedge(G,B)= \; & \{(((e_2,q,1),(e_1,q,1)),\{u_1\}),(((e_2,q,1),(e_2,q,1)),\{u_1,u_3\}),\\ & (((e_2,q,1),(e_2,r,1)),\{u_1\}),(((e_3,p,1),(e_1,q,1)),\{u_4\}),\\ & (((e_3,p,1),(e_2,q,1)),\{u_3\}),(((e_3,p,1),(e_2,r,1)),\{u_4\}),\\ & (((e_3,r,1),(e_1,q,1)),\{u_4\}),(((e_3,r,1),(e_2,q,1)),\emptyset),\\ & (((e_3,r,1),(e_2,r,1)),\{u_4\}),(((e_1,r,0),(e_1,q,1)),\{u_1\}),\\ & (((e_1,r,0),(e_2,q,1)),\{u_1\}),(((e_1,r,0),(e_2,r,1)),\{u_1,u_2\})\}\end{aligned}$$

and

$$\begin{aligned}(F,A)\vee(G,B)= \; & \{(((e_2,q,1),(e_1,q,1)),\{u_1,u_3,u_4\}),(((e_2,q,1),(e_2,q,1)),\{u_1,u_3\}),\\ & (((e_2,q,1),(e_2,r,1)),U),(((e_3,p,1),(e_1,q,1)),\{u_1,u_3,u_4\}),\\ & (((e_3,p,1),(e_2,q,1)),\{u_1,u_3,u_4\}),(((e_3,p,1),(e_2,r,1)),U),\\ & (((e_3,r,1),(e_1,q,1)),\{u_1,u_4\}),(((e_3,r,1),(e_2,q,1)),\{u_1,u_3,u_4\}),\\ & (((e_3,r,1),(e_2,r,1)),\{u_1,u_2,u_4\}),(((e_1,r,0),(e_1,q,1)),\{u_1,u_2,u_4\}),\\ & (((e_1,r,0),(e_2,q,1)),\{u_1,u_2,u_3\}),(((e_1,r,0),(e_2,r,1)),\{u_1,u_2,u_4\})\}\end{aligned}$$

Proposition 2.31. Let (F,A) and (G,B) be two soft expert sets over U. Then

i. $((F,A)\wedge(G,B))^{\tilde{c}}=(F,A)^{\tilde{c}}\vee(G,B)^{\tilde{c}}$

ii. $((F,A)\vee(G,B))^{\tilde{c}}=(F,A)^{\tilde{c}}\wedge(G,B)^{\tilde{c}}$

Proposition 2.32. Let (F,A), (G,B) and (H,C) be three soft expert sets over U. Then

i. $((F,A)\wedge((G,B)\wedge(H,C))=((F,A)\wedge(G,B))\wedge(H,C)$

ii. $((F,A)\vee((G,B)\vee(H,C))=((F,A)\vee(G,B))\vee(H,C)$

Remark 2.33. Since the domains of functions which lay on the right side of the equalities are different from the other side of them, the propositions

iii. $((F,A)\vee((G,B)\wedge(H,C))=((F,A)\vee(G,B))\wedge((F,A)\vee(H,C))$

iv. $((F,A)\wedge((G,B)\vee(H,C))=((F,A)\wedge(G,B))\vee((F,A)\wedge(H,C))$

are not held as it is also shown in [4] for the soft sets.

3 An Application of Soft Expert Sets

In this section, we show that the algorithm given in [5] has some unnecessary steps and that the results of this algorithm and Maji et al's algorithm [13] without reduction are equivalent. Afterwards, we suggest a new algorithm and give an application on decision making by using updated definitions and propositions as a result of remarks above.

Let's consider the algorithm in [5] as in the following,

Algorithm 1.

(1) Input the soft expert set (F, Z),

(2) Find an agree-soft expert set and a disagree-soft expert set,

(3) Find $c_j = \Sigma_i R_X(\alpha_i, u_j)$ for agree-soft expert set,

(4) Find $k_j = \Sigma_i R_X(\alpha_i, u_j)$ for disagree-soft expert set,

(5) Find $s_j = c_j - k_j$,

(6) Find m, for which $s_m = \max_j s_j$.

It is easy to show that, from the Definition 2.11,

$$k_j = |E \times X| - c_j$$

then

$$s_j = c_j - \{|E \times X| - c_j\} = 2c_j - |E \times X|$$

and

$$c_i \leq c_j \Leftrightarrow 2c_i \leq 2c_j \Leftrightarrow (2c_i - |E \times X|) \leq (2c_j - |E \times X|) \Leftrightarrow s_i \leq s_j$$

where, the symbol $|E \times X|$ is the cardinality of $E \times X$. That is, s_j and $\max_j\{s_j\}$ are redundant. So step 5, step 4 and the last part of step 2 are unnecessary. Hence, the algorithm has become Maji et al's algorithm, i.e.,

(1) Input the soft expert set (F, Z),

(2) Find the agree-soft expert set,

(3) Find $c_j = \Sigma_i R_X(\alpha_i, u_j)$ for the agree-soft expert set,

(4) Find m, for which $c_m = \max_j c_j$.

To illustrate, let's consider the application given in [5]. Assume that a company wants to fill a position. There are eight candidates who form the universe $U = \{u_1, u_2, u_3, u_4, u_5, u_6, u_7, u_8\}$. The hiring committee considers a set of parameters, $E = \{e_1, e_2, e_3, e_4, e_5\}$ where the parameters $e_i (i = 1, 2, 3, 4, 5)$ stand for *experience*, *computer knowledge*, *young age*, *elocution* and *friendly*, respectively. Let $X = \{p, q, r\}$ be a set of experts (committee members). Suppose that, after a serious discussion, the committee constructs the soft expert set (F, Z) as in the following,

$$\begin{aligned}(F,Z)= \ & \{((e_1,p,1),\{u_1,u_2,u_4,u_7,u_8\}),((e_1,q,1),\{u_1,u_4,u_5,u_8\}),\\ & ((e_1,r,1),\{u_1,u_3,u_4,u_6,u_7,u_8\}),((e_2,p,1),\{u_3,u_5,u_8\}),\\ & ((e_2,q,1),\{u_1,u_3,u_4,u_5,u_6,u_8\}),((e_2,r,1),\{u_1,u_2,u_4,u_7,u_8\}),\\ & ((e_3,p,1),\{u_3,u_4,u_5,u_7\}),((e_3,q,1),\{u_1,u_2,u_5,u_8\}),((e_3,r,1),\{u_1,u_7,u_8\}),\\ & ((e_4,p,1),\{u_1,u_7,u_8\}),((e_4,q,1),\{u_1,u_4,u_5,u_8\}),((e_4,r,1),\{u_1,u_6,u_7,u_8\}),\\ & ((e_5,p,1),\{u_1,u_2,u_3,u_5,u_8\}),((e_5,q,1),\{u_1,u_4,u_5,u_8\}),((e_1,p,0),\{u_3,u_5,u_6\}),\\ & ((e_1,q,0),\{u_2,u_3,u_6,u_7\}),((e_1,r,0),\{u_2,u_5\}),((e_3,p,0),\{u_1,u_2,u_6,u_8\}),\\ & ((e_5,r,1),\{u_1,u_3,u_5,u_7,u_8\}),((e_2,p,0),\{u_1,u_2,u_4,u_6,u_7\}),((e_2,q,0),\{u_2,u_7\}),\\ & ((e_3,q,0),\{u_3,u_4,u_6,u_7\}),((e_3,r,0),\{u_2,u_3,u_4,u_5,u_6\}),((e_2,r,0),\{u_3,u_5,u_6\}),\\ & ((e_4,p,0),\{u_2,u_3,u_4,u_5,u_6\}),((e_4,q,0),\{u_2,u_3,u_6,u_7\}),((e_4,r,0),\{u_2,u_3,u_4,u_5\}),\\ & ((e_5,p,0),\{u_4,u_6,u_7\}),((e_5,q,0),\{u_2,u_3,u_6,u_7\}),((e_5,r,0),\{u_2,u_4,u_6\})\}\end{aligned}$$

Then the table representation (or briefly table) of $(F,Z)_1$ as in Table 1.

Table 1. The table of agree-soft expert set

R_X	u_1	u_2	u_3	u_4	u_5	u_6	u_7	u_8
$(e_1,p,1)$	1	1	0	1	0	0	1	1
$(e_2,p,1)$	0	0	1	0	1	0	0	1
$(e_3,p,1)$	0	0	1	1	1	0	1	0
$(e_4,p,1)$	1	0	0	0	0	0	1	1
$(e_5,p,1)$	1	1	1	0	1	0	0	1
$(e_1,q,1)$	1	0	0	1	1	0	0	1
$(e_2,q,1)$	1	0	1	1	1	1	0	1
$(e_3,q,1)$	1	1	0	0	1	0	0	1
$(e_4,q,1)$	1	0	0	1	1	0	0	1
$(e_5,q,1)$	1	0	0	1	1	0	0	1
$(e_1,r,1)$	1	0	1	1	0	1	1	1
$(e_2,r,1)$	1	1	0	1	0	0	1	1
$(e_3,r,1)$	1	0	0	0	0	0	1	1
$(e_4,r,1)$	1	0	0	0	0	1	1	1
$(e_5,r,1)$	1	0	1	0	1	0	1	1
$c_j=\Sigma_i R_X(\alpha_i,u_j)$	$c_1=13$	$c_2=4$	$c_3=6$	$c_4=8$	$c_5=9$	$c_6=3$	$c_7=8$	$c_8=14$

Here, R_X is a relation on $Z\times U$, defined by $R_X(\alpha_i,u_j)=\chi_{F(\alpha_i)}(u_j)$ such that $R_X(\alpha_i,u_j)$ is the entries corresponding the ith row and jth column in table representation of R_X and

$$\chi_{F(\alpha_i)}(u_j)=\begin{cases}1, & u_j\in F(\alpha_i)\\ 0, & otherwise\end{cases}$$

Hence, the committee can choose candidate 8 for the job since $\max_j c_j=c_8$.

Note that the order of c_j,

$$c_8>c_1>c_5>c_4=c_7>c_3>c_2>c_6$$

obtained by Maji et al's algorithm without reduction, is the same as the order obtained by Alkhazaleh and Salleh's algoritm.

Let's give a new definition and an algorithm which is different from the others.

Definition 3.1. The soft expert set (F, A) is called p-part of (F, Z), denoted by $p(F, Z)$, such that $A = E \times \{p\} \times O$ for $p \in X$.

For example,

$$\begin{aligned} p(F,Z) = \ & \{((e_1,p,1),\{u_1,u_2,u_4\}),((e_2,p,1),\{u_4\}),((e_3,p,1),\{u_3,u_4\}), \\ & ((e_1,p,0),\{u_3\}),((e_2,p,0),\{u_1,u_2,u_3\}),((e_3,p,0),\{u_1,u_2\})\} \end{aligned}$$

is a part of (F, Z) given in Example 2.2.

Note that $p(F, Z)_1$ can be seen as a soft set over U and written simply as in the following,

$$p(F,Z)_1 = \{(e_1,\{u_1,u_2,u_4\}),(e_2,\{u_4\}),(e_3,\{u_3,u_4\})\}$$

Algorithm 2.

(1) Construct a soft expert set,

(2) Find the parts of agree-soft expert set,

(3) Find the consensus soft set by using s-intersection to all parts of agree-soft expert set.

(4) Find $c_j = \Sigma_i R_C(e_i, u_j)$ for consensus,

(5) Find $\{u_k : c_k = \max_j c_j\}$.

To illustrate, let's consider the application above. Then the table representation of all parts of agree-soft expert sets as in the following,

Table 2. The table of $p(F, Z)_1$

R_p	u_1	u_2	u_3	u_4	u_5	u_6	u_7	u_8
e_1	1	1	0	1	0	0	1	1
e_2	0	0	1	0	1	0	0	1
e_3	0	0	1	1	1	0	1	0
e_4	1	0	0	0	0	0	1	1
e_5	1	1	1	0	1	0	0	1

Table 3. The table of $q(F, Z)_1$

R_q	u_1	u_2	u_3	u_4	u_5	u_6	u_7	u_8
e_1	1	0	0	1	1	0	0	1
e_2	1	0	1	1	1	1	0	1
e_3	1	1	0	0	1	0	0	1
e_4	1	0	0	1	1	0	0	1
e_5	1	0	0	1	1	0	0	1

Table 4. The table of $r(F, Z)_1$

R_r	u_1	u_2	u_3	u_4	u_5	u_6	u_7	u_8
e_1	1	0	1	1	0	1	1	1
e_2	1	1	0	1	0	0	1	1
e_3	1	0	0	0	0	0	1	1
e_4	1	0	0	0	0	1	1	1
e_5	1	0	1	0	1	0	1	1

Here, R_p is a relation on $E \times U$, defined by $R_p(e_i, u_j) = \chi_{F(e_i)}(u_j)$ such that $R_p(e_i, u_j)$ is the entries corresponding the ith row and jth column in table representation of R_p and

$$\chi_{F(e_i)}(u_j) = \begin{cases} 1, & u_j \in F(e_i) \\ 0, & otherwise \end{cases}$$

Let's obtain the consensus soft set by soft intersection of all parts of the agree-soft expert set and show as in the following,

Table 5. The table of the consensus soft set

R_C	u_1	u_2	u_3	u_4	u_5	u_6	u_7	u_8
e_1	1	0	0	1	0	0	0	1
e_2	0	0	0	0	0	0	0	1
e_3	0	0	0	0	0	0	0	0
e_4	1	0	0	0	0	0	0	1
e_5	1	0	0	0	1	0	0	1
$c_j = \Sigma_i R_C(e_i, u_j)$	$c_1 = 3$	$c_2 = 0$	$c_3 = 0$	$c_4 = 1$	$c_5 = 1$	$c_6 = 0$	$c_7 = 0$	$c_8 = 4$

By Table 5, we have the following results;

$$c_8 > c_1 > c_4 = c_5 > c_2 = c_3 = c_6 = c_7$$

Since $\max_j c_j = c_8$, the committee can choose the candidate with number 8 for the job.

4 Conclusion

The concept of soft sets has idiosyncratic serious problems because of some of their definitions as the soft complement. Enginoğlu [8] overcame such problems by characteristic sets. Similarly, the concept of soft expert sets can provide dealing with the difficulty arising from the definition of soft complement in [11] by assuming $(\neg e_i, p_j, 1) = (e_i, p_j, 0)$. This is important for the development of soft sets, and it is worth doing the study on it when viewed from this aspect. People who want to study on this concept should not ignore this detail.

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