4 Applications

The methods of nonparametric tests with fuzzy data mentioned in [5, 6] can only deal with interval-valued data. But in real, there are various kinds of fuzzy data. If we apply the two methods to other kinds of fuzzy data, the outcome will not appropriate to the fact. Cheng [1] can rank all kinds of convex fuzzy data without mention nonparametric tests with fuzzy data. Later we will take the prime time for marriage as an example to illustrate our method can solve both problems mentioned above.

The prime time for marriage is an important issue that we are interested in. But the measurement for the prime time for marriage is not easy. In order to measure the prime time for marriage more precisely, we design a fuzzy questionnaire as Fig.7 by using GSP. Besides, 8 masters form NCCU. were invited to do this fuzzy questionnaire. In this experiment, respondents are asked to follow the steps mentioned before and we can gain a fuzzy sample based on their feeling. We want to compare our method with the two different methods in [1] [5] and check at the $\alpha = 0.05$ level of significance whether the median of the prime time for marriage is [28, 29] by Wilcoxon signed-ranks test?

Example 4.1 *The fuzzy samples about the prime time for marriage from 8 masters are showed and the calculations for obtaining the test statistics for three different methods are summarized in Table 4, 5, 6, respectively. At the* $\alpha = 0.05$ *level of significance does the median of the population equals to [28, 29] by Wilcoxon signed-ranks test?*

Table 4 Wilcoxon signed-ranks test with fuzzy data using center points

method	Master	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8
	Data	[25,30,31]	[25,30,31,33]	[28,33]	[26,31,32]	[30, 34]	[26,30,31,34]	[30, 32]	[25, 30]
Center point	$Q(\tilde{A}_i)$	28	29	30.5	29	32	30	31	27.5
	d_i	0.5	0.5	2	0.5	3.5	1.5	2.5	1
	$A_i - A_0$	-	+	+	+	+	+	+	-
	r_i	2	2	6	2	8	5	7	4
	$W^+ = \sum_{i=1}^{n} I_i r_i = 30$, $W^- = \sum_{i=1}^{n} I'_i r_i = 6$, $T = \min\{W^+, W^-\} = 6$, N=8. $H_0 : M = [28, 29]$ *vs* $H_1 : M \neq [28, 29]$. Because $W_{0.05} = 4 < T = 6$, hence accept H_0.								

Table 5 Wilcoxon signed-ranks test with fuzzy data using Lin's method

method	Master	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8
	Data	[25,30,31]	[25,30,31,33]	[28,33]	[26,31,32]	[30, 34]	[26,30,31,34]	[30, 32]	[25, 30]
Lin	$Q(\tilde{A}_i)$	28.67	29.26	30.5	29.67	32	30.19	31	27.5
	d_i	0.17	0.76	2	1.17	3.5	1.69	2.5	1
	$A_i - A_0$	+	+	+	+	+	+	+	-
	r_i	1	2	6	4	8	5	7	3
	$W^+ = \sum_{i=1}^{n} I_i r_i = 33$, $W^- = \sum_{i=1}^{n} I'_i r_i = 3$, $T = \min\{W^+, W^-\} = 3$, N=8. $H_0 : M = [28, 29]$ *vs* $H_1 : M \neq [28, 29]$. Because $W_{0.05} = 4 > T = 3$, hence reject H_0.								

Table 6 Wilcoxon signed-ranks test with fuzzy data using geometric points

method	master	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8
	data	[25,30,31]	[25,30,31,33]	[28,33]	[26,31,32]	[30, 34]	[26,30,31,34]	[30, 32]	[25, 30]
Geome-tric point	$\tilde{x}(i)$	28.67	29.26	30.5	29.67	32	30.19	31	27.5
	$\tilde{y}(i)$	0.51	0.50	0.50	0.51	0.50	0.50	0.50	0.50
	$Q(\tilde{A}_i)$	28.67	29.26	30.50	29.67	32.00	30.19	31.00	27.50
	d_i	0.17	0.76	2	1.17	3.5	1.69	2.5	1
	$A_i - A_0$	+	+	+	+	+	+	+	-
	r_i	1	2	6	4	8	5	7	3
	$W^+ = \sum_{i=1}^n I_i r_i = 33$, $W^- = \sum_{i=1}^n I'_i r_i = 3$, $T = \min\{W^+, W^-\} = 3$, N=8. $H_0 : M = [28, 29]$ *vs* $H_1 : M \neq [28, 29]$. Because $W_{0.05} = 4 > T = 3$, hence reject H_0								

Note: $\tilde{x}(i) = \frac{\int xu(x)dx}{\int u(x)dx}$, $\tilde{y}(i) = \frac{\int_0^1 yg(y)dy}{\int_0^1 g(y)dy}$ where $g(y)$ is an inverse function of $u(x)$

In Table 4, 5, 6 these data about the prime time for marriage form 8 masters are tested by using three different methods. If the null hypothesis is obviously not true, a powerful test should reject it. By observing these fuzzy samples, most data are skew. Using center points to rank data is not appropriate. And using geometric points to rank is to complex in computing. Our method not only has better interpretations but also has fewer limits to data types.