Grading Multiple Choice exams at the DPECS

Test Committee, Oliver Lindemann

Risbo and Remindo use different methods to calculate a grade from a score (i.e., number correct answers) in a multiple choice exam.

Risbo's method

Risbo uses a single linear interpolation between the point of the pass-fail criterion, P_1, and the highest possible grade, P_2. The smallest passing score has to fulfil the criterion of at least 55% knowledge, that is, 55% correct questions after guessing correction. Importantly, the calculated passing score will to be rounded up.

For example, if we have $n = \textbf{40 questions with 4 choices}$, the guessing correction is $c_g = 40/4 = 10$. With a knowledge criterion $k_p = .55$ and a passing grade $g_p = 5.5$, the passing score s_p is:

$$s_p = k_p(n - c_g) + c_g = .55\,(40 - 10) + 10 = 26.5 \rightarrow 27$$

Thus, if the highest possible grade is $g_h = 10$, the interpolation uses the following two points:

$$P_1 = (s_p, g_p) = (27, 5.5)$$

$$P_2 = (n, g_h) = (40, 10)$$

Remindo's method

Remindo's method[1] is somewhat different from the method used by Risbo:

1. If answer options of the some questions will be excluded after the exam, the guessing correction will be adapted accordingly.
2. The calculated passing score will not be rounded up. With the example above, the interpolation uses the point $P_1 = (26.5, 5.5)$.
3. The method uses a bi-linear interpolation. That is, one interpolation for all score between the pass-fail criterion (see above) and separate linear interpolation for the scores between the guessing rate and the pass-fail criteria.

Summary

Remindo grades are slightly higher for all grades below the pass-fail criterion (due to 3.) and the grades above and close to 5.5 (due to 2.). The bilinear interpolation ensures that if students have one question more correct than the guessing rate, they receive grade higher than 1. This is not the case in Risbo's methods of grading (see tables below).

An implementation of the grading in `R` to calculate the grades for any exam can be found online https://github.com/lindemann09/eur_test_committee/tree/master/grading

Find below the grading procedure of multiple choise exam often used at the DEPCS.

---

[1]Please note that I have only access to the grades of few Remindo exams and I don't know whether this applies to all Remindo exams.

MC exam with 40 questions and 4 choises

Risbo's method:

$$grade = \begin{cases} -3.846 + 0.346 \cdot score & \text{if } score > 14 \\ 1 & \text{if } score \leq 14 \end{cases}$$

Remindo's method:

$$grade = \begin{cases} -3.333 + 0.333 \cdot score & \text{if } score \geq 26.5 \\ -1.727 + 0.273 \cdot score & \text{if } 10 < score < 26.5 \\ 1 & \text{if } score \leq 10 \end{cases}$$
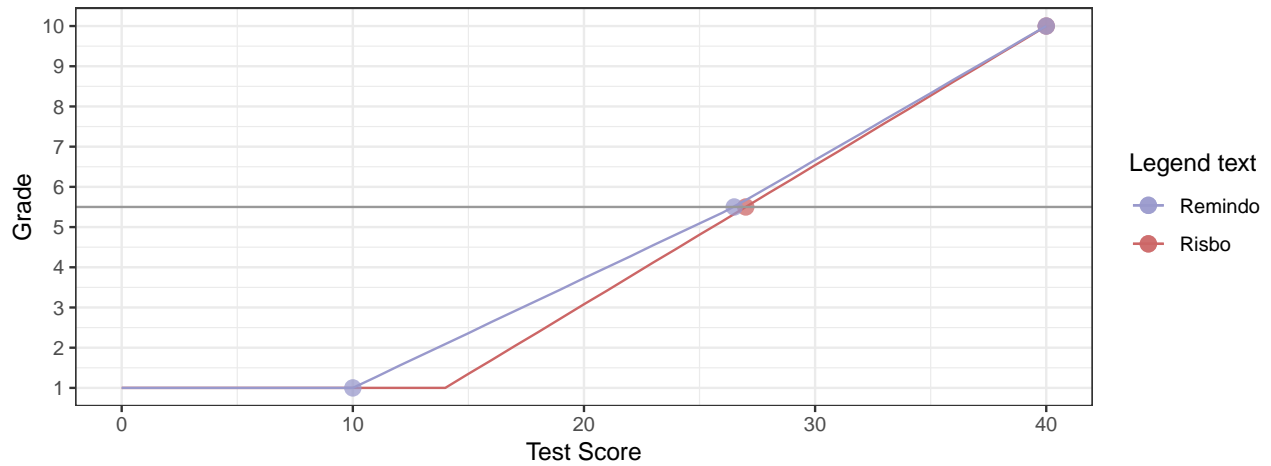

Table 1: Grading table

score.1	risbo.1	remindo.1	score.2	risbo.2	remindo.2
1	1.0	1.0	21	3.4	4.0
2	1.0	1.0	22	3.8	4.3
3	1.0	1.0	23	4.1	4.5
4	1.0	1.0	24	4.5	4.8
5	1.0	1.0	25	4.8	5.1
6	1.0	1.0	26	5.2	5.4
7	1.0	1.0	27	5.5	5.7
8	1.0	1.0	28	5.8	6.0
9	1.0	1.0	29	6.2	6.3
10	1.0	1.0	30	6.5	6.7
11	1.0	1.3	31	6.9	7.0
12	1.0	1.5	32	7.2	7.3
13	1.0	1.8	33	7.6	7.7
14	1.0	2.1	34	7.9	8.0
15	1.3	2.4	35	8.3	8.3
16	1.7	2.6	36	8.6	8.7
17	2.0	2.9	37	9.0	9.0
18	2.4	3.2	38	9.3	9.3
19	2.7	3.5	39	9.7	9.7
20	3.1	3.7	40	10.0	10.0

MC exam with 50 questions and 3 choises

Risbo's method:

$$grade = \begin{cases} -5 + 0.3 \cdot score & \text{if } score > 20 \\ 1 & \text{if } score \leq 20 \end{cases}$$

Remindo's method:

$$grade = \begin{cases} -5 + 0.3 \cdot score & \text{if } score \geq 35 \\ -3.091 + 0.245 \cdot score & \text{if } 16.67 < score < 35 \\ 1 & \text{if } score \leq 16.67 \end{cases}$$
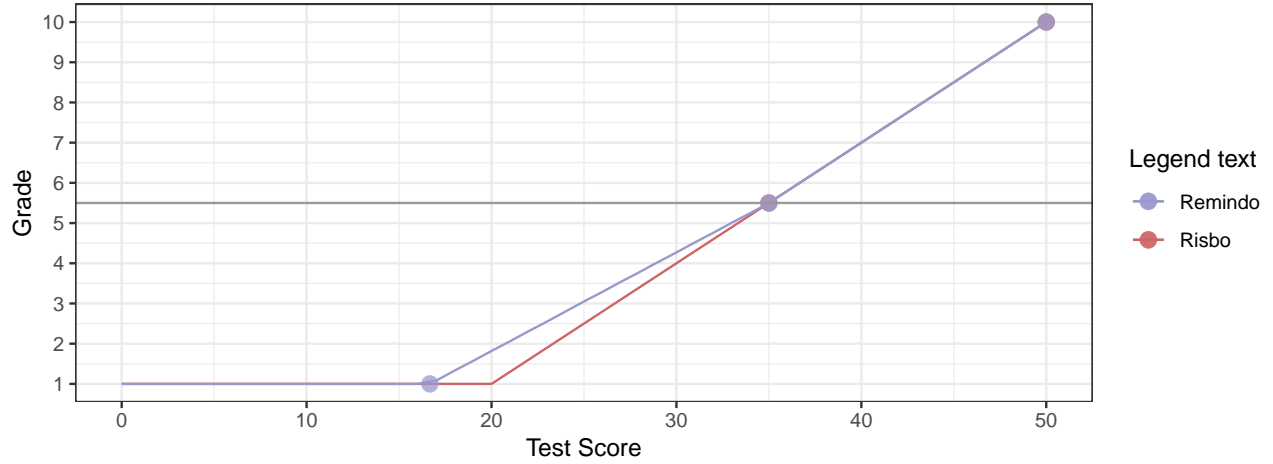

Table 2: Grading table

score.1	risbo.1	remindo.1	score.2	risbo.2	remindo.2	score.3	risbo.3	remindo.3
1	1	1.0	21	1.3	2.1	41	7.3	7.3
2	1	1.0	22	1.6	2.3	42	7.6	7.6
3	1	1.0	23	1.9	2.6	43	7.9	7.9
4	1	1.0	24	2.2	2.8	44	8.2	8.2
5	1	1.0	25	2.5	3.0	45	8.5	8.5
6	1	1.0	26	2.8	3.3	46	8.8	8.8
7	1	1.0	27	3.1	3.5	47	9.1	9.1
8	1	1.0	28	3.4	3.8	48	9.4	9.4
9	1	1.0	29	3.7	4.0	49	9.7	9.7
10	1	1.0	30	4.0	4.3	50	10.0	10.0
11	1	1.0	31	4.3	4.5	NA	NA	NA
12	1	1.0	32	4.6	4.8	NA	NA	NA
13	1	1.0	33	4.9	5.0	NA	NA	NA
14	1	1.0	34	5.2	5.3	NA	NA	NA
15	1	1.0	35	5.5	5.5	NA	NA	NA
16	1	1.0	36	5.8	5.8	NA	NA	NA
17	1	1.1	37	6.1	6.1	NA	NA	NA
18	1	1.3	38	6.4	6.4	NA	NA	NA
19	1	1.6	39	6.7	6.7	NA	NA	NA
20	1	1.8	40	7.0	7.0	NA	NA	NA

MC exam with 50 questions and 4 choises

Risbo's method:

$$grade = \begin{cases} -4.062 + 0.281 \cdot score & \text{if } score > 18 \\ 1 & \text{if } score \leq 18 \end{cases}$$

Remindo's method:

$$grade = \begin{cases} -3.333 + 0.267 \cdot score & \text{if } score \geq 33.12 \\ -1.727 + 0.218 \cdot score & \text{if } 12.5 < score < 33.12 \\ 1 & \text{if } score \leq 12.5 \end{cases}$$
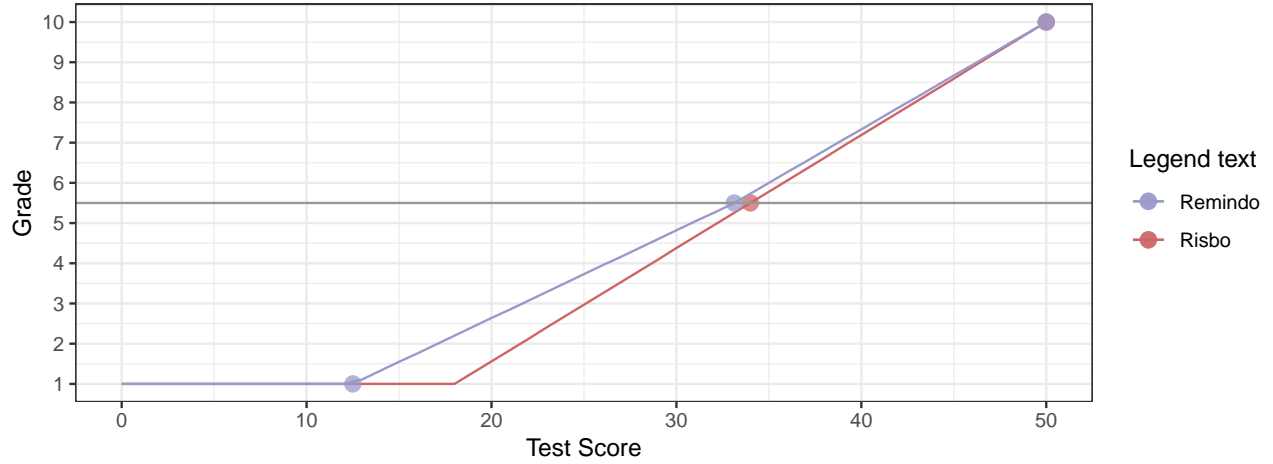

Table 3: Grading table

score.1	risbo.1	remindo.1	score.2	risbo.2	remindo.2	score.3	risbo.3	remindo.3
1	1.0	1.0	21	1.8	2.9	41	7.5	7.6
2	1.0	1.0	22	2.1	3.1	42	7.8	7.9
3	1.0	1.0	23	2.4	3.3	43	8.0	8.1
4	1.0	1.0	24	2.7	3.5	44	8.3	8.4
5	1.0	1.0	25	3.0	3.7	45	8.6	8.7
6	1.0	1.0	26	3.2	3.9	46	8.9	8.9
7	1.0	1.0	27	3.5	4.2	47	9.2	9.2
8	1.0	1.0	28	3.8	4.4	48	9.4	9.5
9	1.0	1.0	29	4.1	4.6	49	9.7	9.7
10	1.0	1.0	30	4.4	4.8	50	10.0	10.0
11	1.0	1.0	31	4.7	5.0	NA	NA	NA
12	1.0	1.0	32	4.9	5.3	NA	NA	NA
13	1.0	1.1	33	5.2	5.5	NA	NA	NA
14	1.0	1.3	34	5.5	5.7	NA	NA	NA
15	1.0	1.5	35	5.8	6.0	NA	NA	NA
16	1.0	1.8	36	6.1	6.3	NA	NA	NA
17	1.0	2.0	37	6.3	6.5	NA	NA	NA
18	1.0	2.2	38	6.6	6.8	NA	NA	NA
19	1.3	2.4	39	6.9	7.1	NA	NA	NA
20	1.6	2.6	40	7.2	7.3	NA	NA	NA

MC exam with 60 questions and 3 choises

Risbo's method:

$$grade = \begin{cases} -5 + 0.25 \cdot score & \text{if } score > 24 \\ 1 & \text{if } score \leq 24 \end{cases}$$

Remindo's method:

$$grade = \begin{cases} -5 + 0.25 \cdot score & \text{if } score \geq 42 \\ -3.091 + 0.205 \cdot score & \text{if } 20 < score < 42 \\ 1 & \text{if } score \leq 20 \end{cases}$$
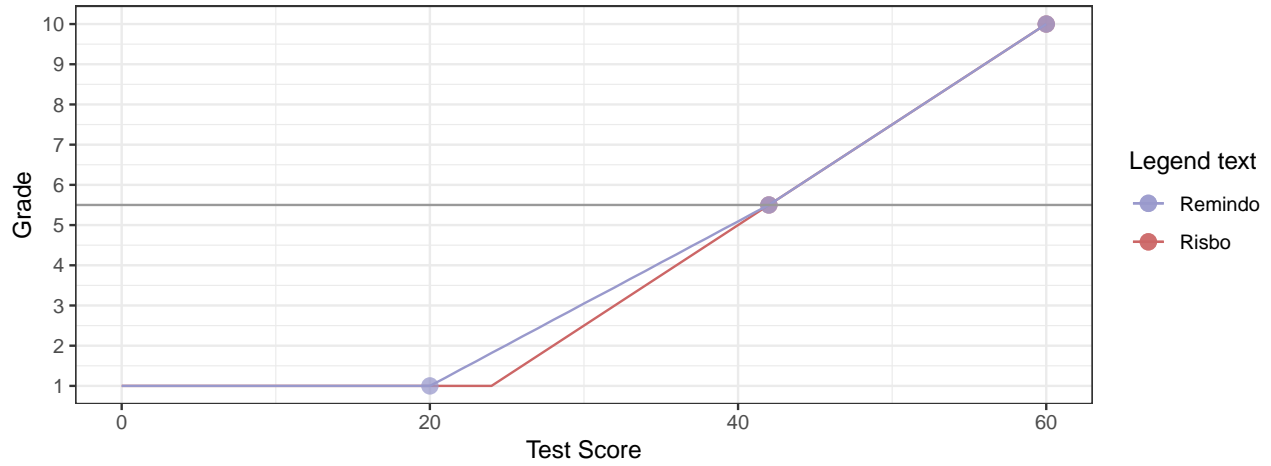

Table 4: Grading table

score.1	risbo.1	remindo.1	score.2	risbo.2	remindo.2	score.3	risbo.3	remindo.3
1	1	1	21	1.0	1.2	41	5.2	5.3
2	1	1	22	1.0	1.4	42	5.5	5.5
3	1	1	23	1.0	1.6	43	5.8	5.8
4	1	1	24	1.0	1.8	44	6.0	6.0
5	1	1	25	1.2	2.0	45	6.2	6.2
6	1	1	26	1.5	2.2	46	6.5	6.5
7	1	1	27	1.8	2.4	47	6.8	6.8
8	1	1	28	2.0	2.6	48	7.0	7.0
9	1	1	29	2.2	2.8	49	7.2	7.2
10	1	1	30	2.5	3.0	50	7.5	7.5
11	1	1	31	2.8	3.3	51	7.8	7.8
12	1	1	32	3.0	3.5	52	8.0	8.0
13	1	1	33	3.2	3.7	53	8.2	8.2
14	1	1	34	3.5	3.9	54	8.5	8.5
15	1	1	35	3.8	4.1	55	8.8	8.8
16	1	1	36	4.0	4.3	56	9.0	9.0
17	1	1	37	4.2	4.5	57	9.2	9.2
18	1	1	38	4.5	4.7	58	9.5	9.5
19	1	1	39	4.8	4.9	59	9.8	9.8
20	1	1	40	5.0	5.1	60	10.0	10.0

MC exam with 80 questions and 2 choises

Risbo's method:

$$grade = \begin{cases} -10 + 0.25 \cdot score & \text{if } score > 44 \\ 1 & \text{if } score \leq 44 \end{cases}$$

Remindo's method:

$$grade = \begin{cases} -10 + 0.25 \cdot score & \text{if } score \geq 62 \\ -7.182 + 0.205 \cdot score & \text{if } 40 < score < 62 \\ 1 & \text{if } score \leq 40 \end{cases}$$
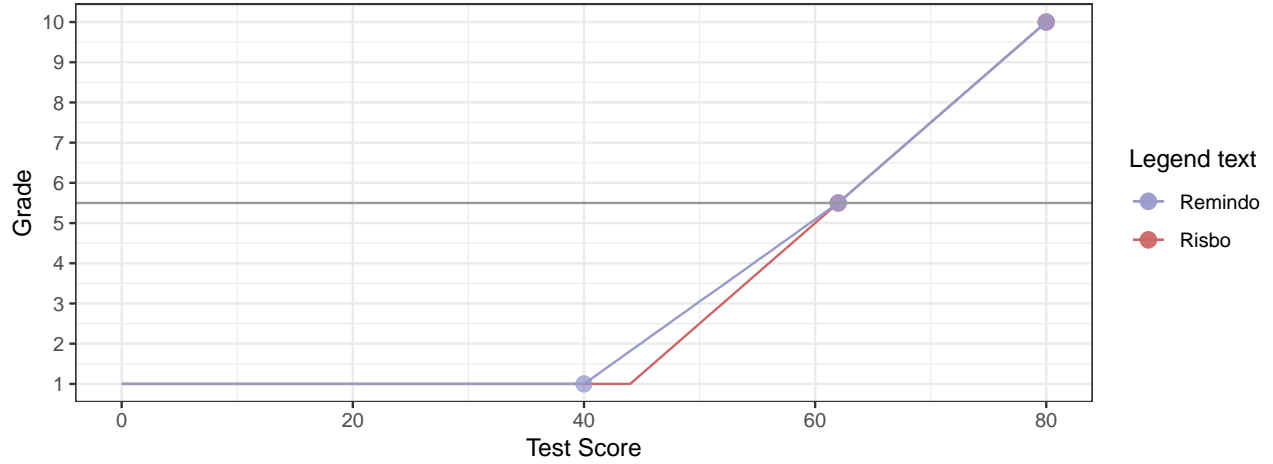

Table 5: Grading table

score.1	risbo.1	remindo.1	score.2	risbo.2	remindo.2	score.3	risbo.3	remindo.3	score.4	risbo.4	remindo.4
1	1	1	21	1	1	41	1.0	1.2	61	5.2	5.3
2	1	1	22	1	1	42	1.0	1.4	62	5.5	5.5
3	1	1	23	1	1	43	1.0	1.6	63	5.8	5.8
4	1	1	24	1	1	44	1.0	1.8	64	6.0	6.0
5	1	1	25	1	1	45	1.2	2.0	65	6.2	6.2
6	1	1	26	1	1	46	1.5	2.2	66	6.5	6.5
7	1	1	27	1	1	47	1.8	2.4	67	6.8	6.8
8	1	1	28	1	1	48	2.0	2.6	68	7.0	7.0
9	1	1	29	1	1	49	2.2	2.8	69	7.2	7.2
10	1	1	30	1	1	50	2.5	3.0	70	7.5	7.5
11	1	1	31	1	1	51	2.8	3.2	71	7.8	7.8
12	1	1	32	1	1	52	3.0	3.5	72	8.0	8.0
13	1	1	33	1	1	53	3.2	3.7	73	8.2	8.2
14	1	1	34	1	1	54	3.5	3.9	74	8.5	8.5
15	1	1	35	1	1	55	3.8	4.1	75	8.8	8.8
16	1	1	36	1	1	56	4.0	4.3	76	9.0	9.0
17	1	1	37	1	1	57	4.2	4.5	77	9.2	9.2
18	1	1	38	1	1	58	4.5	4.7	78	9.5	9.5
19	1	1	39	1	1	59	4.8	4.9	79	9.8	9.8
20	1	1	40	1	1	60	5.0	5.1	80	10.0	10.0

MC exam with 90 questions and 2 choises

Risbo's method:

$$grade = \begin{cases} -10.25 + 0.225 \cdot score & \text{if } score > 50 \\ 1 & \text{if } score \leq 50 \end{cases}$$

Remindo's method:

$$grade = \begin{cases} -10 + 0.222 \cdot score & \text{if } score \geq 69.75 \\ -7.182 + 0.182 \cdot score & \text{if } 45 < score < 69.75 \\ 1 & \text{if } score \leq 45 \end{cases}$$
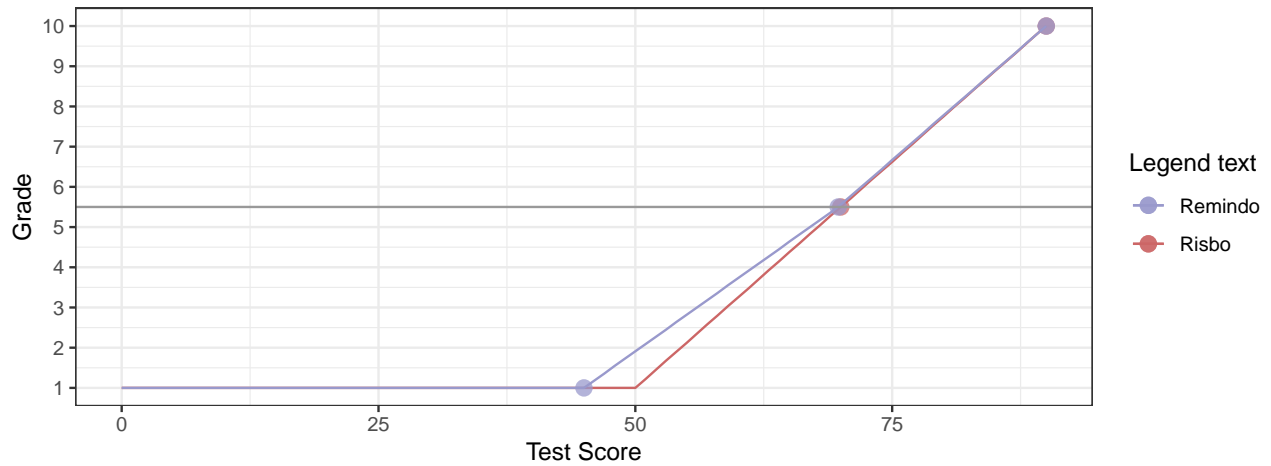

Table 6: Grading table

score.1	risbo.1	remindo.1	score.2	risbo.2	remindo.2	score.3	risbo.3	remindo.3	score.4	risbo.4	remindo.4	score.5	risbo.5	remindo.5
1	1	1	21	1	1	41	1.0	1.0	61	3.5	3.9	81	8.0	8.0
2	1	1	22	1	1	42	1.0	1.0	62	3.7	4.1	82	8.2	8.2
3	1	1	23	1	1	43	1.0	1.0	63	3.9	4.3	83	8.4	8.4
4	1	1	24	1	1	44	1.0	1.0	64	4.2	4.5	84	8.7	8.7
5	1	1	25	1	1	45	1.0	1.0	65	4.4	4.6	85	8.9	8.9
6	1	1	26	1	1	46	1.0	1.2	66	4.6	4.8	86	9.1	9.1
7	1	1	27	1	1	47	1.0	1.4	67	4.8	5.0	87	9.3	9.3
8	1	1	28	1	1	48	1.0	1.5	68	5.1	5.2	88	9.6	9.6
9	1	1	29	1	1	49	1.0	1.7	69	5.3	5.4	89	9.8	9.8
10	1	1	30	1	1	50	1.0	1.9	70	5.5	5.6	90	10.0	10.0
11	1	1	31	1	1	51	1.2	2.1	71	5.7	5.8	NA	NA	NA
12	1	1	32	1	1	52	1.5	2.3	72	5.9	6.0	NA	NA	NA
13	1	1	33	1	1	53	1.7	2.5	73	6.2	6.2	NA	NA	NA
14	1	1	34	1	1	54	1.9	2.6	74	6.4	6.4	NA	NA	NA
15	1	1	35	1	1	55	2.1	2.8	75	6.6	6.7	NA	NA	NA
16	1	1	36	1	1	56	2.3	3.0	76	6.9	6.9	NA	NA	NA
17	1	1	37	1	1	57	2.6	3.2	77	7.1	7.1	NA	NA	NA
18	1	1	38	1	1	58	2.8	3.4	78	7.3	7.3	NA	NA	NA
19	1	1	39	1	1	59	3.0	3.5	79	7.5	7.6	NA	NA	NA
20	1	1	40	1	1	60	3.2	3.7	80	7.8	7.8	NA	NA	NA