An algorithm of rating horses by beaten distances

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The basic philosophy on which the rating scheme for horses called performance rate is constructed is whether one horse is better than another, and by how many lengths.

For horses which run in the same race, it is possible to obtain direct comparisons. For horses which do not run against each other, comparisons are still possible through the intermediary of other horses.

A system to calculate a quantity to represent beaten distances was formulated by iterative computer processes. For this program the author used FORTRAN by HITAC M-200.

Materials

Horse numbers and beaten distances in No. 1–20 races are taken from the report by WATANABE[4].

1

896	0.0
614	3.00
475	8.00
519	11.50
366	20.50

2

361	0.0
388	0.15
1036	4.15
83	4.65
922	5.15
874	5.90
612	7.90
1072	8.90
934	9.65
913	10.15

3

275	0.0
613	2.50
550	3.75
615	5.00
566	6.00
182	8.50
652	8.80
209	11.30
842	11.60
246	13.10

4

654	0.0
788	2.00
223	3.25
51	5.00
247	7.50
349	8.25
857	10.75
567	12.25
319	16.25
793	22.25

5

439	0.0
654	3.50
1047	7.50
60	7.80
146	8.55
247	11.05
1017	11.20
1083	11.25
236	11.30
857	12.30
950	15.30

6

909	0.0
275	4.00
475	4.30
737	11.30
973	12.80
615	13.55
825	13.85

7

519	0.0
297	4.00
356	7.00
38	8.75
288	13.75
474	17.25

8

275	0.0
146	1.75
945	4.25
331	6.75
1017	8.75
723	10.53

9

313	0.0
62	0.30
253	0.60
183	4.10
878	5.60
186	6.85
663	9.35
181	9.85
1007	10.15
1090	11.40
894	15.40

10

909	0.0
27	4.00
817	9.00
615	10.00
255	10.50
93	11.25
406	12.25
566	13.00
976	13.15
366	17.15
782	22.15

11

878	0.0
198	5.00
945	5.75
47	6.50
124	9.50
1048	11.25
790	11.30
247	13.05
668	13.80
857	15.55

12

883	0.0
186	1.75
512	2.25
705	2.75
864	4.25
684	4.75
796	5.25
487	7.75

13

275	0.0
194	3.50
547	6.00
550	6.75
464	6.90
475	8.15
106	9.15
883	10.40
898	13.40

14

494	0.0
883	1.00
1007	4.50
654	7.00
331	10.50
60	11.00
1017	11.75

15

519	0.0
550	7.00
120	9.00
983	9.50
684	11.00
51	11.15

16

223	0.0
1057	0.05
894	4.05
864	5.30
487	6.30
16	8.35
523	10.10
71	19.10
269	19.10

17

1063	0.0
652	1.25
193	1.75
255	3.00
591	3.75
439	4.50
474	4.80
562	4.85
62	7.35
607	7.65

18

1090	0.0
878	0.05
406	1.80
1031	1.95
161	3.95
306	5.95
133	6.25
975	7.25
66	12.25
456	12.55
585	21.55

19

449	0.0
972	0.50
847	1.25
106	2.00
651	2.30
738	2.60
388	2.90
905	3.20
369	3.70
473	5.45
664	6.95
1075	7.00
982	7.15
210	9.65

20

248	0.0
748	1.25
1047	1.55
356	1.85
519	3.35
492	3.40
616	4.65
607	5.90
297	6.20
887	6.25
494	6.55
663	8.30
591	11.80
626	15.30

The explanation of this program

N ; number of horses

K ; number of races

$$e(i,j)=\begin{cases}0, & \text{if horses i does not finish race j}\\ 1, & \text{if horse i finish race j}\end{cases}$$

NR(i) ; number of races in which horse i finishes

MH(j) ; number of horses which finish in race j

D(i,j) ; matrix of beaten distances (N×K)

PR(i) ; performance rate

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ISN                                    SOURCE STATEMENT
00000001            DIMENSION IH(400),D(400,30),NR(400),
                    IE(400,30),PR(400)
                   *,MH(30)
00000002            I=1
00000003            J=1
00000004         10 READ(5,5000)NN,IH(I),D(I,J)
00000005            IE(I,J)=1
00000006            IF(NN.EQ.0)GO TO 20
00000007            IF(NN.NE.1)GO TO 30
00000008            I=I+1
00000009            J=J+1
00000010            GO TO 10
                C
00000011         20 I=I+1
00000012            GO TO 10
                C
00000013         30 K=J
00000014            N=I
                C
00000015            WRITE(6,5500)(IH(I),(D(I,J),J=1,K),I=1,N)
00000016            CALL MATRIX(N,K,D,IH,IE,NR)
00000017            WRITE(6,9000)
00000018            WRITE(6,1000)(I,IH(I),(D(I,J),J=1,K),I=1,N)
00000019            WRITE(6,9000)
00000020            WRITE(6,2000)(I,IH(I),(IE(I,J),J=1,K),I=1,N)
00000021            CALL NOHO(N,K,IE,MH)
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00000022          CALL PRATE(N,K,D,NR,MH,IE,PR)
00000023          WRITE(6,9000)
00000024          WRITE(6,3000)(I,IH(I),PR(I),I=1,N)
00000025          STOP
00000026     3000 FORMAT(10 X,I 5,2 X,I 5,5 X,F 8.3)
00000027     2000 FORMAT(I 5,2 X,I 5,20 I 5)
00000028     9000 FORMAT(1 H 1)
00000029     5500 FORMAT(5 X,I 5,2 X,20 F 6.2)
00000030     1000 FORMAT(I 5,2 X,I 5,20 F 6.2)
00000031     5000 FORMAT(I 1,4 X,I 5,5 X,F 5.2)
00000032          END

00000001          SUBROUTINE MATRIX(N,K,D,IH,IE,IP)
00000002          REAL NEWD
00000003          DIMENSION NEWD(400,30),D(400,30),NH(400),
                  IH(400),IP(400)
                 *,IE(400,30),NE(400,30)
00000004          DO 10 J=1,K
00000005          NE(1,J)=IE(1,J)
00000006          NEWD(1,J)=D(1,J)
00000007       10 CONTINUE
00000008          NH(1)=IH(1)
00000009          IN=1
00000010          IP(IN)=1
                C
00000011          DO 100 I=2,N
00000012          DO 20 IR=1,IN
00000013          IF(IH (I).NE.NH(IR))GO TO 20
00000014          IP(IR=IP(IR)+1
                C
00000015          DO 15 J=1,K
00000016          NE(IR,J)=NE(IR,J)+IE(I,J)
00000017          NEWD(IR,J)=NEWD(IR,J)+D(I,J)
00000018       15 CONTINUE
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```
      C
00000019            GO TO 100
00000020         20 CONTINUE
00000021            IN=IN+1
00000022            IP(IN)=1
00000023            DO 30 J=1,K
00000024            NE(IN,J)=IE(I,J)
00000025            NEWD(IN,J)=D(I,J)
00000026         30 CONTINUE
00000027            NH(IN)=IH(I)
00000028        100 CONTINUE
      C
00000029            N=IN
00000030            DO 40 I=1,N
00000031            IKS=0
00000032            IH(I)=NH(I)
00000033            DO 50 J=1,K
00000034            IE(I,J)=NE(I,J)
00000035            D(I,J)=NEWD(I,J)
00000036         50 CONTINUE
00000037         40 CONTINUE
      C
      C
00000038            RETURN
00000039            END

00000001            SUBROUTINE TORACE(N,K,D,TK)
00000002            DIMENSION D(400,30),TK(400)
00000003            DO 20 I=1,N
00000004            TKS=0.
00000005            DO 10 J=1,K
00000006            TKS=TKS+D(I,J)
00000007         10 CONTINUE
00000008            TK(I)=TKS
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```
00000009      20 CONTINUE
00000010         RETURN
00000011         END

00000001         SUBROUTINE NOHO(N,K,IE,MH)
00000002         DIMENSION IE(400,30),MH(30)
00000003         DO 20 J=1,K
00000004         M=0
00000005         DO 10 I=1,N
00000006         IF(IE(I,J).NE.1)GO TO 10
00000007         M=M+1
00000008      10 CONTINUE
00000009         MH(J)=M
00000010      20 CONTINUE
00000011         RETURN
00000012         END

00000001         SUBROUTINE ESTIRA(N,K,D,IE,HBAR,S)
00000002         DIMENSION D(400,30),IE(400,30),HBAR(400),S(400,30)
00000003         DO 5 I=1,N
00000004         DO 5 J=1,K
00000005       5 S(I,J)=0.
00000006         DO 20 I=1,N
00000007         DO 10 J=1,K
00000008         IF (IE(I,J).NE.1)GO TO 10
00000009         S(I,J)=D(I,J)-HBAR(I)
00000010      10 CONTINUE
00000011      20 CONTINUE
00000012         RETURN
00000013         END

00000001         SUBROUTINE RACEBA(MH,N,K,S,TNJ)
00000002         DIMENSION S(400,30),TNJ(30),MH(30)
00000003         DO 20 J=1,K
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```
00000004          TN=0.
00000005          DO 10 I=1,N
00000006          TN=TN+S(I,J)
00000007       10 CONTINUE
00000008          TNJ(J)=TN/FLOAT(MH(J))
00000009       20 CONTINUE
00000010          RETURN
00000011          END

00000001          SUBROUTINE HEIKIN(N,TD,NR,HBAR)
00000002          DIMENSION HBAR(400),TD(400),NR(400)
00000003          DO 10 I=1,N
00000004          HBAR(I)=TD(I)/FLOAT(NR(I))
00000005       10 CONTINUE
00000006          RETURN
00000007          END

00000001          SUBROUTINE PRATE(N,K,D,NR,MH,IE,PR)
00000002          DIMENSION D(400,30),TD(400),NR(400),
                  HBAR(400),S(400,30)
                 *,TNJ(30),TTD(400),EBAR(400)
                 *,DO(400,30),AHE(400)
                 *,MH(30)
                 *,IE(400,30)
00000003          A=0.001
00000004          ITR=1
00000005          CALL TORACE(N,K,D,TD)
00000006          CALL HEIKIN(N,TD,NR,HBAR)
00000007       10 CALL ESTIRA(N,K,D,IE,HBAR,S)
00000008          CALL RACEBA(MH,N,K,S,TNJ)
00000009          CALL DDMATR(N,K,IE,D,TNJ,DD)
00000010          CALL TORACE(N,K,DD,TTD)
00000011          CALL HEIKIN(N,TTD,NR,EBAR)
00000012          DO 20 I=1,N
```

```
00000013          SM=0.
00000014          SM=ABS(HBAR(I)-EBAR(I))
00000015          IF(SM.GT.A)GO TO 40
00000016       20 CONTINUE
00000017          DO 30 I=1,N
00000018       30 PR(I)=EBAR(I)
00000019          WRITE(6,1000)ITR
00000020     1000 FORMAT(10X,'ITR='I5)
00000021          GO TO 70
00000022       40 DO 60 I=1,N
00000023          HBAR(I)=EBAR(I)
00000024          TD(I)=TTD(I)
00000025          DO 50 J=1,K
00000026       50 D(I,J)=DD(I,J)
00000027       60 CONTINUE
00000028          ITR=ITR+1
00000029          GO TO 10
00000030       70 RETURN
00000031          END

00000001          SUBROUTINE DDMATR(N,K,IE,D,TNJ,DD)
00000002          DIMENSION IE(400,30),D(400,30),TNJ(30),DD(400,30)
00000003          DO 50 I=1,N
00000004          DO 50 J=1,K
00000005       50 DD(I,J)=0.
00000006          DO 20 J=1,K
00000007          DO 10 I=1,N
00000008          IF(IE(I,J).NE.1)GO TO 10
00000009          DD(I,J)=D(I,J)-TNJ(J)
00000010       10 CONTINUE
00000011       20 CONTINUE
00000012          RETURN
00000013          END
```

The results

H. No.	P. R.
1	494	2.636
2	883	3.905
3	1007	6.671
4	654	5.659
5	331	10.314
6	60	10.290
7	1017	12.013
8	439	3.079
9	1047	3.957
10	146	6.909
11	247	12.671
12	1083	12.210
13	236	12.260
14	857	15.004
15	950	16.259
16	313	− 2.127
17	62	3.111
18	253	− 1.527
19	183	1.973
20	878	3.035
21	186	5.558
22	663	6.713
23	181	7.723
24	1090	7.051
25	894	12.019
26	519	− 0.989
27	550	2.900
28	120	6.794
29	983	7.294
30	684	9.093
31	51	9.320
32	909	− 6.381
33	27	− 2.381
34	817	2.619
35	615	4.780
36	255	3.908
37	93	4.869
38	406	6.249
39	566	5.586
40	976	6.769
41	366	10.470
42	782	15.768
43	275	− 1.604
44	945	6.656
45	723	13.087
46	896	−10.329
47	614	− 7.329
48	475	− 0.469
49	361	4.696
50	388	4.855
51	1036	8.846
52	83	9.346
53	922	9.846
54	874	10.596
55	612	12.596
56	1072	13.596
57	934	14.346
58	913	14.846
59	1031	6.779
60	161	8.779
61	306	10.779
62	133	11.079
63	975	12.079
64	66	17.077
65	456	17.377
66	585	26.377
67	512	6.893
68	705	7.393
69	864	10.454
70	796	9.893
71	487	12.704
72	737	4.919
73	973	6.419
74	825	7.469
75	788	6.697
76	223	7.331
77	349	12.947
78	567	16.946
79	319	20.946
80	793	26.946
81	248	− 2.097
82	748	− 0.847
83	356	1.289
84	492	1.303
85	616	2.553
86	607	6.075
87	297	1.964
88	887	4.153
89	591	7.075
90	626	13.203
91	38	4.575
92	288	9.575
93	474	9.287
94	194	− 1.647
95	547	0.853
96	464	1.753
97	106	3.984
98	898	8.253
99	1057	6.765
100	16	15.065
101	523	16.813
102	71	25.813
103	269	25.813
104	198	5.755
105	47	7.255
106	124	10.255
107	1048	12.005
108	790	12.055
109	668	14.555
110	613	1.052
111	182	7.052
112	652	4.650
113	209	9.852
114	842	10.152
115	246	11.652
116	449	1.965
117	972	2.465
118	847	3.215
119	651	4.265
120	738	4.565
121	905	5.165
122	369	5.665
123	473	7.415
124	664	8.915
125	1075	8.965
126	982	9.115
127	210	11.615
128	1063	0.698
129	193	2.448
130	562	5.548

H.No. ; Horse Number
P.R. ; Performance rate

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着差による馬の評点の一演算法

渡辺　裕

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馬の性能評価の一方法として，着差を基にしたパフォーマンス　レイトがある。計算機プログラムをFORTRANを用いて作成し，今後の軽種馬の改良に資することを目的とした。