Olympic Medal SVM

Yijia Dai

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We have created a matrix whose rows are indexed by Olympic teams and whose columns are indexed by sports. The (i, j) entry of the matrix counts the combined number of medals (gold, silver, and bronze) that team i won in sport j from 1980 to 2016.

An important step of preprocessing is to remove the centroid of the data vectors. The SVM is seeking a best-fit linear subspace, as we proved in question 3, SVM could help to find the best-fit subspace when the centroid is . After removing the mean for the vectors, we also normalized each column. It is done under the assumption that the sports are relatively independent from each other for each country. We make this decision with tradeoff between the dependency of different sports and the clearance of the countries ranking.

Then, we compute the singular value decomposition of this matrix. For the top four singular values, we take the associated left and right singular vectors u and v, and generate tables ranking Olympic teams i in ascending order of u_i and ranking sports j in ascending order of v_j .

Figure 1 shows the 38 singular values. For the convenience of visualizing, two zero values are patched to form a (8×5) table. The actual singular values are stored in a (38×51) matrix.

	0	1	2	3	4
0	0.886364	0.678023	0.553199	0.513609	0.507386
1	0.465595	0.436586	0.412766	0.348220	0.331071
2	0.290833	0.262573	0.258286	0.239348	
3	0.221460	0.209522	0.185786	0.171585	0.154596
4	0.147084	0.131733	0.122548	0.118610	0.104547
5	0.098577	0.089517	0.081266	0.069348	0.059773
6	0.052158	0.051287	0.041817	0.034885	0.029742
7	0.018495	0.016170	0.000000	0.000000	0.000000

Figure 1: Table for all singular values.

The tables are shown in Figure 2-5 have the first columns listing team names or sports names, the second column listing the corresponding components of the singular vector in ascending order.

Interesting patterns are shown within the ranking of teams and sports. For example, the ranking of the teams corresponding to the first left singular vector has the precedence of "The United States", "China", "Russia", "Canada", "Australia", "Great Britain", "Germany"... which is an "accurate" approximate indicator of the ranking of countries performance in recent decades. We can see the absolute value of the vector's dimensions are in a wide range with the U.S. about 0.75. It means that the characteristic of these teams are very prominent in this direction. The sports with absolute value large are reasonably the sports like Swimming that the top-ranking teams are good at.

At the second singular vector, China plays a dominant role with a dimension value of 0.78. And the corresponding sports, Badminton, Table Tennis, and Weighting, are the sports that China is good at. Similarly, there exists a strong correlation between Spain and Beach Volleyball on the third singular vector.

Moreover, the third right singular vector shows positive components are predominantly summer sports and whose negative components are predominantly winter sports. And many European and high-latitude teams are listed in negative components correspondingly.

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27 Norway 0.089407 36 Rhythmic Gymnastics -0.05195 28 Belarus 0.093378 38 Rugby Sevens -0.05051 29 Denmark 0.097475 39 Modern Pentathlon -0.04768 30 Finland 0.099720 41 Alpine Skiing -0.04125 31 Yugoslavia 0.100637 42 Luge -0.03932 32 Austria 0.101848 43 Biathlon -0.03377 44 Hockey -0.03224 45 Canoeing -0.01878 34 Croatia 0.109757 46 Nordic Combined -0.00486	26	West Germany	0.089287	35	Triathlon	-0.068159
28 Belarus 0.093378 38 Rugby Sevens -0.050519 29 Denmark 0.097475 39 Modern Pentathlon -0.04168 30 Finland 0.099720 41 Alpine Skiing -0.04125 31 Yugoslavia 0.100637 42 Luge -0.03932 32 Austria 0.101848 43 Biathlon -0.03377 33 Argentina 0.105129 45 Canoeing -0.01878 34 Croatia 0.109757 46 Nordic Combined -0.0488	27	Norway				-0.051956
29 Denmark 0.097475 39 Modern Pentathlon -0.04768 30 Finland 0.099720 40 Bobsleigh -0.04817 31 Yugoslavia 0.100637 42 Luge -0.0332 32 Austria 0.101848 43 Biathlon -0.0337 33 Argentina 0.105129 44 Hockey -0.01274 34 Croatia 0.109757 46 Nordic Combined -0.00486		•				
29 Denmark 0.0974/5 40 Bobsleigh -0.04617 30 Finland 0.099720 41 Alpine Skiing -0.04125 31 Yugoslavia 0.100637 42 Luge -0.03932 32 Austria 0.101848 43 Biathlon -0.0337 33 Argentina 0.105129 44 Hockey -0.01878 34 Croatia 0.109757 46 Nordic Combined -0.00486						
30 Finland 0.099720 41 Alpine Sking -0.04125 31 Yugoslavia 0.100637 42 Luge -0.03932 32 Austria 0.101848 43 Biathlon -0.03377 33 Argentina 0.105129 44 Hockey -0.01878 34 Croatia 0.109757 46 Nordic Combined -0.00486	29	Denmark	0.097475			-0.046173
32 Austria 0.101848 43 Biathlon -0.03377 33 Argentina 0.105129 44 Hockey -0.03224 34 Croatia 0.109757 46 Nordic Combined -0.0486	30	Finland	0.099720			-0.041254
33 Argentina 0.101848 44 Hockey -0.03224 45 Canoeing -0.01878 34 Croatia 0.109757 46 Nordic Combined -0.00486	31	Yugoslavia	0.100637	42	Luge	-0.039322
33 Argentina 0.105129 45 Canoeing -0.01878 34 Croatia 0.109757 46 Nordic Combined -0.00488	32	Austria	0.101848	43	Biathlon	-0.033775
34 Croatia 0.109757 46 Nordic Combined -0.00486	33	Argentina	0.10 <u>5129</u>			-0.032249
47		-				
an Liverin Benjiniic						0.004849
48 Cross Country Skiing 0.00765	35	·	0.110483			0.007651
36 Jamaica 0.113645	36	Jamaica	0.113645	49	Beach Volleyball	0.027561
37 Czechoslovakia 0.116788 ₅₀ Ski Jumping 0.03590	37	Czechoslovakia	0.116788	50	Ski Jumping	0.035907

Figure 2: Table for the teams and sports corresponding to sorted 1st singular vectors.

		Sport		Vector	
Team		Vector	0	Swimming	-0.184702
0	United States	-0.384097	1	Snowboarding	-0.171256
1	Australia	-0.177684	2	Equestrianism	-0.167908
			3	Tennis	-0.160743
2	Great Britain	-0.167861	4	Athletics Sailing	-0.155628 -0.151126
3	Switzerland	-0.116227	6	Triathlon	-0.138781
4	France	-0.097002	7	Basketball	-0.134870
5	Germany	-0.093450	8	Cycling	-0.129323
6	Spain	-0.082553	9	Skeleton	-0.126566
7	Austria	-0.081026	10	Alpine Skiing	-0.111916
		0.00.000	11	Bobsleigh	-0.103086
8	Netherlands	-0.064155	12	Rowing	-0.098650
9	Canada	-0.056212	13	Water Polo	-0.094537
10	Norway	-0.053289	14	Rugby Sevens	-0.093688
11	New Zealand	-0.052931	16	Ice Hockey Softball	-0.087297 -0.085472
12	Sweden	-0.033244	17	Figure Skating	-0.083657
		-0.030437	18	Nordic Combined	-0.075953
13	Finland	-0.030437	19	Football	-0.072224
14	Brazil	-0.025318	20	Beach Volleyball	-0.062523
15	Argentina	-0.024946	21	Hockey	-0.062523
16	East Germany	-0.023401	22	Freestyle Skiing	-0.061617
17	West Germany	-0.018974	23	Canoeing	-0.058563
18	Czech Republic	-0.012057	24	Speed Skating	-0.055602 -0.051311
	·		25 26	Curling	-0.051311
19	Soviet Union	-0.011996	27	Ski Jumping	-0.041652
20	Jamaica	-0.010239	28	Modern Pentathlon	-0.031873
21	Czechoslovakia	-0.004671	29	Biathlon	-0.029564
22	Croatia	-0.001521	30	Baseball	-0.021879
23	Hungary	-0.001361	31	Cross Country Skiing	-0.019991
24	Yugoslavia	0.006053	32	Boxing	-0.007017
	-		33	Wrestling	0.022981
25	Italy	0.007968	35	Volleyball	0.023039
26	Poland	0.021835	36	Handball	0.043312
27	Unified Team	0.026695	37	Golf	0.062732
28	Cuba	0.031357	38	Judo	0.077187
29	Romania	0.032233	39	Synchronized Swimming	0.081530
30	Belarus	0.045724	40	Gymnastics	0.089246
			41	Rhythmic Gymnastics	
31	Ukraine	0.055500	42 43	Taekwondo Short Track Speed Skating	0.110958 0.134833
32	Denmark	0.061677	44	Archery	0.134633
33	Bulgaria	0.072185	45	Shooting	0.176081
34	Japan	0.077773	46	Diving	0.242945
35	Russia	0.117700	47	Trampolining	0.267266
36	South Korea	0.286492	48	Weightlifting	0.292731
			49	Table Tennis	0.383267
37	China	0.781455	50	Badminton	0.414862

Figure 3: Table for the teams and sports corresponding to sorted 2nd singular vectors.

			Sport		Vector
	Team	Vector	0	Biathlon	-0.193827
0	Germany	-0.318343	1	Luge	-0.188395
1	Austria	-0.177882	2	Nordic Combined	-0.176426
2	Norway	-0.170417	3	Ski Jumping	-0.163661 -0.133744
	•		4 5	Cross Country Skiing Alpine Skiing	-0.133744
3	Canada	-0.138035	6	Curling	-0.130516
4	France	-0.116712	7	Canoeing	-0.112995
5	Finland	-0.096633	8	Bobsleigh	-0.091653
6	Switzerland	-0.082541	9	Speed Skating	-0.090281
7	Great Britain	-0.075422	10	Equestrianism	-0.081732
		5.5. 5	11	Rowing	-0.078802
8	Sweden	-0.058934	12	Skeleton	-0.074771
9	Italy	-0.057925	13	Fencing	-0.074205
10	East Germany	-0.055523	14	Trampolining	-0.072674
11	Soviet Union	-0.033997	15	Snowboarding Freestyle Skiing	-0.071611 -0.054976
12	Russia	-0.033041	17	Ice Hockey	-0.054365
			18	Modern Pentathlon	-0.048963
13	Hungary	-0.022518	19	Shooting	-0.045762
14	Poland	-0.019560	20	Cycling	-0.042011
15	West Germany	-0.011682	21	Table Tennis	-0.041000
16	Netherlands	-0.010802	22	Rugby Sevens	-0.040449
17	China	-0.010272	23	Diving	-0.028654
18	Romania	-0.006091	24	Triathlon	-0.027229
			25 26	Weightlifting Figure Skating	-0.019785 -0.014305
19	New Zealand	-0.002161	27	Judo	-0.007410
20	Czech Republic	0.001593	28	Short Track Speed Skating	0.000401
21	Ukraine	0.006514	29	Boxing	0.002014
22	Czechoslovakia	0.011668	30	Wrestling	0.008546
23	Belarus	0.014140	31	Gymnastics	0.008730
24	Unified Team	0.014369	32	Golf	0.009444
			33	Football	0.015260
25	Bulgaria	0.020092	34	Athletics Swimming	0.017088 0.022056
26	Jamaica	0.021885	36	Volleyball	0.022030
27	Denmark	0.025087	37	Badminton	0.027710
28	Japan	0.025612	38	Hockey	0.031001
29	Yugoslavia	0.044615	39	Handball	0.046028
	· ·		40	Archery	0.053470
30	Croatia	0.045831	41	Softball	0.060187
31	Brazil	0.049771	42	Baseball	0.066892
32	Cuba	0.050338	43	Synchronized Swimming	0.079250
33	Australia	0.055449	44	Rhythmic Gymnastics Sailing	0.080379 0.083429
34	Argentina	0.056435	46	Taekwondo	0.101700
35	South Korea	0.093497	47	Water Polo	0.104364
			48	Tennis	0.149940
36	United States	0.106086	49	Basketball	0.170168
37	Spain	0.855509	50	Beach Volleyball	0.794137

Figure 4: Table for the teams and sports corresponding to sorted 3rd singular vectors.

			Sport		Vector
	Team	Vector	0	Rugby Sevens	-0.373235
0	Great Britain	-0.511014	1	Bobsleigh	-0.289855
1	Canada	-0.326496	2	Triathlon	-0.249104
2	Australia	-0.288469	3	Curling	-0.231312 -0.181939
	New Zealand	-0.246169	5	Sailing	-0.148481
3			6	Badminton	-0.138535
4	China	-0.166454	7	Cycling	-0.136883
5	Switzerland	-0.123088	8	Trampolining	-0.114782
6	Denmark	-0.104917	9	Short Track Speed Skating	-0.113449
7	South Korea	-0.085280	10	Rowing	-0.100902
8	Netherlands	-0.076067	11	Hockey Skeleton	-0.093540 -0.067337
9	Sweden	-0.054088	13	Table Tennis	
_			14	Freestyle Skiing	
10	France	-0.053132	15	Softball	
11	Argentina	-0.039819	16	Diving	
12	Jamaica	-0.032116	17	Taekwondo	
13	Czech Republic	-0.023920	18	Equestrianism	
14	Czechoslovakia	-0.020304	19	Ice Hockey Archery	
15	Croatia	-0.012097	21	Swimming	-0.029637
16	Ukraine	0.007302	22	Tennis	0.015540
			23	Baseball	0.028632
17	West Germany	0.015148	24	Judo	0.042721
18	Yugoslavia	0.017532	25	Snowboarding	0.050257
19	Romania	0.023003	26	Athletics	0.057259
20	Brazil	0.026164	27	Speed Skating Modern Pentathlon	0.060792 0.065030
21	Poland	0.030332	29	Figure Skating	0.070743
22	Unified Team	0.037690	30	Weightlifting	0.072065
			31	Handball	0.088126
23	Belarus	0.038422	32	Basketball	0.088781
24	Finland	0.053097	33	Beach Volleyball	0.092702
25	Cuba	0.055894	34	Shooting	0.093082
26	East Germany	0.061993	35 36	Synchronized Swimming Alpine Skiing	0.095343
27	Japan	0.074303	37	Gymnastics	0.093549
28	Bulgaria	0.075255	38	Football	0.102441
29	Spain	0.092720	39	Boxing	0.102873
	·		40	Canoeing	0.107780
30	Hungary	0.094131	41	Volleyball	0.142082
31	United States	0.118711	42	Ski Jumping	0.144607
32	Austria	0.128464	43	Water Polo Nordic Combined	0.146803 0.155361
33	Norway	0.151698	45	Fencing	0.169057
34	Soviet Union	0.161034	46	Wrestling	0.182367
35	Italy	0.226412	47	Cross Country Skiing	0.193949
36	Germany	0.266499	48	Rhythmic Gymnastics	0.238637
	•		49	Luge	0.255463
37	Russia	0.407626	50	Biathlon	0.259711

Figure 5: Table for the teams and sports corresponding to sorted 4th singular vectors.