Who's the GOAT ?

Tables accompanying the article

"Ranking athletes and teams across epochs"

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1 Fitness and Prestige across 50 years

In all tables presented below, the fitness and prestige scores are rescaled so that the maximum entry is 1000. For sports where this makes sense, we compute a yearly equivalent points chess score (expressed in ‰ of a perfect maximum) and further determine the *peak* year for each participant as the zenith of her smoothed inter temporal scoring function.

1.1 Football

The outcome of a league match is coded with 3 points for a victory (per current regulation).[1] For knockout tournaments (e.g., FIFA nations, UEFA clubs or national cups), we use the aforementioned fair prize structure.

1.1.1 National Leagues

We start with pioneer England. The left panel of Table 1 displays chess points, strength and fitness for the 2018-19 championship. We observe that *Manchester City* won by one point and deservedly so as indicated by its maximum strength. However, the WinLoss ratio of vice-champion *Liverpool* was higher, which made its fitness greater. To understand this discrepancy, recall that under strength, each team receives $\lambda = 45$ points (for that particular set of data) to be traded with other teams in order to acquire victories, the price vector equilibrating all budgets is the strength vector $\vec{s}$. Under fitness, each team trades his defeats and since *Liverpool* suffered only 1 while *Manchester City* lost 4 times, this mechanically raises *Liverpool*'s fitness; within any given game, they are

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[1] The change from 2 to 3 points per victory brought more ??offensive to break ties but also more defense by the game leader (to avoid the tie); overall it had a very small impact on the number of goals per game.

a more dangerous competitor than *Manchester City* (say, more likely to tie or win the game after a bad start).

Over the long run, the right panel of Table 1 computes prestige for the 50 teams that participated in the Premier League over half a century (recall there are only 20 in a given year). There is good agreement with fitness except for *Chelsea* who has a higher relative fitness than prestige, being a relative newcomer in the league's top5.

2018-19 ENG	Chess	Strength	Fitness
Liverpool FC	97	949	1000
Manchester City	98	1000	921
Chelsea FC	72	677	269
Arsenal FC	70	641	182
Manchester United	66	610	166
Tottenham	71	639	152
Wolverhampton	57	604	147
Leicester City	52	514	144
Everton FC	54	516	117
Crystal Palace	49	460	111
West Ham United	52	484	99
Newcastle United	45	398	89

1970-2021 ENG	Fitness	Prestige
Liverpool FC	1000	1000
Manchester United	937	959
Arsenal FC	845	945
Tottenham	551	780
Everton FC	508	759
Chelsea FC	726	750
Manchester City	593	679
Aston Villa	467	604
Newcastle United	451	555
West Ham United	393	553
Southampton FC	414	551
Leeds United	626	478

Table 1: English Premier League Football

In Spain, as may be seen on the left panel of Table 2, *FC Barcelona* and *Real Madrid* have largely dominated the past half century, with nearly identical prestige and fitness, way above contenders. The right panel displays the 2016-17 season. Although *Barcelona* showed brilliance by beating the best teams (and achieving higher strength), rival *Madrid* showed constance by maintaining a better WinLoss ratio and fitness, thus collecting more chess points and the title.

1970-2021 ESP	Fitness	Prestige
FC Barcelona	976	1000
Real Madrid	1000	995
Atlético Madrid	597	802
Valencia CF	498	763
Athletic Bilbao	430	731
Real Sociedad	430	687
Sevilla FC	440	660
Espanyol Barcelona	344	615
Real Betis	361	532
Real Zaragoza	350	488
Celta Vigo	338	453
Deportivo La Coruña	444	394

2016-17 ESP	Chess	Strength	Fitness
Real Madrid	93	984	1000
FC Barcelona	90	1000	976
Atlético Madrid	78	773	425
Sevilla FC	72	757	380
Villarreal CF	67	694	308
CD Alavés	55	609	236
Athletic Bilbao	63	635	199
Real Sociedad	64	592	198
SD Eibar	54	549	164
Málaga CF	46	494	161
Valencia CF	46	472	138
Celta Vigo	45	424	115

Table 2: Spanish “La Liga” football league

We end this section with the prestige ranking from several major football playing countries.

1985-2022 ARG	Fitness	Prestige
Boca Juniors	915	1000
River Plate	1000	955
Vélez Sarsfield	772	919
San Lorenzo	701	877
Newell’s Old Boys	629	851
Estudiantes	626	819
Independiente	642	809
Racing Club	622	803
Lanús	743	761
Gimnasia de La Plata	528	715
Rosario Central	557	679
Argentinos Juniors	495	634

1995-2022 BRA	Fitness	Prestige
Corinthians SP	942	1000
Santos FC	1000	954
Atlético Mineiro	876	853
Grêmio Porto Alegre	826	795
Cruzeiro	842	793
São Paulo FC	907	748
Palmeiras	932	723
Athletico Paranaense	879	705
Fluminense RJ	770	692
Internacional	899	675
Flamengo RJ	856	667
Vasco da Gama	780	657

Table 3: Argentina “Primera División ”& Brazil “Série A”

1970-2021 DEU	Fitness	Prestige
Bayern München	1000	1000
Borussia Dortmund	538	757
Werder Bremen	449	727
Bor. Mönchengladbach	430	702
Hamburger SV	443	687
VfB Stuttgart	426	680
FC Schalke 04	411	642
Bayer Leverkusen	542	607
Eintracht Frankfurt	364	606
1. FC Köln	378	575
1. FC Kaiserslautern	409	515
Hertha BSC	349	452

1970-2021 FRA	Fitness	Prestige
Paris Saint-Germain	1000	1000
Girondins Bordeaux	827	966
AS Monaco	971	949
Olympique Marseille	931	917
Olympique Lyon	907	910
FC Nantes	790	868
Lille OSC	667	777
AS Saint-Étienne	704	768
OGC Nice	626	687
FC Metz	562	664
RC Lens	644	628
Stade Rennes	579	626

Table 4: German Bundesliga & French “Ligue 1”

1970-2021 ITA	Fitness	Prestige
Juventus	1000	1000
Inter	686	895
AC Milan	718	877
AS Roma	588	840
SSC Napoli	558	701
ACF Fiorentina	421	687
Lazio Roma	475	686
Sampdoria	366	558
Torino FC	394	549
Udinese Calcio	324	484
Atalanta	335	453
Bologna FC	295	435

1996-2022 USA	Fitness	Prestige
Los Angeles Galaxy	755	1000
D.C. United	706	748
Columbus Crew	554	706
New England Revolution	462	614
Chicago Fire	541	611
Seattle Sounders	864	567
Colorado Rapids	455	555
Houston Dynamo	621	489
San Jose Earthquakes	640	473
Real Salt Lake	622	472
New York RB	595	456
FC Dallas	613	401

Table 5: Italian “Serie A” & USA Major League Soccer

1.1.2 Club Competitions

We study the European Champions League (CL) and the Copa Libertadores de América. The former presents a specific challenge; if we were to employ solely the games actually played, maximum fitness would belong to English club *Nottingham Forest* (Forest) who participated only three times, winning twice. Now, as only the top 3 or 4 teams of major European leagues are drafted to the CL, the very fact that Forest did not make it since 1980 is proof it has been a consistently worse team than any other English team playing the CL (and for that matter than any current first league

member). For that reason, we add a fictitious lost game for *Forest* against each of the 4 English participant in the 2021 CL. This consideration is applied to the 200 best teams over the 1970-2021 period: in any given year, a team not playing the CL is given lost games against his nation's representatives in that year's CL.

Table 6 shows the dominance of *Real Madrid* over that competition (excluding here 6 early titles and the 2022 one). Note how *Juventus* achieves a high prestige even though it only won twice because it has lost many finals, thus proving an enduring ability to beat the best quite often (in order to reach the final).

1970-2021 Europe	Fitness	Prestige	pts(‰)
Real Madrid	1000	1000	227
Bayern München	648	854	220
Liverpool FC	982	734	169
FC Barcelona	783	716	152
Juventus	590	667	125
AC Milan	983	648	125
Manchester United	708	495	87
Chelsea FC	710	442	82
AFC Ajax	925	434	105
Borussia Dortmund	451	245	42
Inter	430	226	48
Arsenal FC	410	224	35
Atlético Madrid	287	221	46
Olympique Marseille	461	193	30
FC Porto	377	188	62
AS Monaco	307	156	24
Paris Saint-Germain	293	151	31
PSV Eindhoven	384	150	38
Hamburger SV	304	139	29
Manchester City	249	134	27

Table 6: Champions League

Table 7 presents the ranking for the *Copa Libertadores* with Argentinian *Boca Junior* and *River Plate* standing above the pack, thanks to their many victories and runner-ups while the recent repeating winner *Palmeiras* of Brazil is already fourth.

1970-2021 America	Fitness	Prestige	pts(‰)
Boca Juniors (arg)	956	1000	159
River Plate (arg)	943	978	137
São Paulo FC (bra)	589	603	86
Palmeiras (bra)	694	587	73
Grêmio Porto Alegre (bra)	607	577	89
Club Olimpia (par)	1000	520	117
Cruzeiro (bra)	588	471	53
Flamengo RJ (bra)	722	439	51
Independiente (arg)	759	423	60
Internacional (bra)	564	389	56
Corinthians SP (bra)	692	383	38
Estudiantes (arg)	558	346	45
Atlético Nacional (col)	472	340	56
Santos FC (bra)	415	336	56
Nacional (uru)	549	319	70
Vélez Sarsfield (arg)	468	319	32
América de Cali (col)	355	315	48
Colo-Colo (chl)	550	289	38
Newell's Old Boys (arg)	439	285	37
San Lorenzo (arg)	484	273	35

Table 7: Copa Libertadores

1.1.3 Country Competitions

The most frequent format used for world and continental football cups is a first group stage of simultaneous round-robins then followed by a 4 stages knockout; the points are 128, 64, 32 and 16 in the KO (in the manner previously explained) and 4 per victory in the RR. Qualification matches (played prior to the cup) award 2 points per victory. We start with continental prestige for the continental tournaments of Europe, South America and Africa before presenting the world ranking solely based on World cup elimination games and tournament proper.

In Europe, the Top3 is occupied by the repeating winners and the Czech Republic, heir to the now defunct mighty Czechoslovakian team. There is a clear wedge between the latest winner Italy and followers. For America, there is no doubt that *Brazil* is both the fittest and most prestigious country, with the Top5 ranking following closely the number of victories.

Europe	Fitness	Prestige
France	1000	1000
Germany	512	934
Spain	865	898
Czech Republic	709	707
Portugal	508	699
Italy	499	681
Greece	792	452
Netherlands	364	432
Denmark	462	431
England	329	348
Russia	266	335
Belgium	148	162
Sweden	211	141
Romania	219	126
Hungary	163	118

America	Fitness	Prestige
Brazil	1000	1000
Uruguay	905	847
Argentina	592	610
Chile	544	542
Colombia	434	500
Peru	365	477
Paraguay	420	456
Mexico	373	262
Bolivia	176	106
Ecuador	164	90
Honduras	967	75
Venezuela	115	72
USA	125	34
Costa Rica	191	27
Japan	138	5

Table 8: Europe & South America

In Africa (with the inclusion of the 2021 cup played in early 2022), three teams have consistently occupied top spots, thus earning high prestige, however none makes it into the Top20 world ranking. The Top5 is occupied by the countries with at least 2 victories since 1970; Italy achieves a notable third place having won twice and been runner-up also twice. Even though the *Netherlands* never won the world cup, they have been runner-up twice and performed consistently, thus surpassing one time winner *Spain* in prestige. The main difference between fitness and prestige is best seen by the *Brazil* vs *Germany* contrast (since 1970). The former either wins the title or leaves the tournament early on; their top fitness makes them very hard to beat. Prestige favors *Germany* because this team manages to play more matches against all the other great teams; it went 6 times into the final losing 3 and winning 3 (vs 3/1 for *Brazil*).

Africa	Fitness	Prestige
Egypt	1000	1000
Cameroon	982	907
Nigeria	563	799
Ivory Coast	669	616
Ghana	429	538
Algeria	528	522
Zambia	418	460
Congo DR	380	384
Senegal	343	379
Tunisia	401	375
Morocco	373	324
South Africa	257	259
Mali	219	245
Burkina Faso	210	214
Sudan	195	211

World Cup	Fitness	Prestige
Germany	716	1000
Brazil	1000	895
Italy	643	806
France	469	666
Argentina	549	663
Netherlands	160	356
Spain	451	337
Belgium	200	277
England	178	224
Uruguay	123	219
Mexico	193	215
Poland	128	210
Sweden	126	206
South Korea	184	192
Bulgaria	82	176

Table 9: Africa & World

1.2 US team sports

We consider the 4 majors professional sports of baseball, (gridiron) football, basketball and hockey as well as college football which provided the stimulus for many academic ranking efforts. In each sport, the championship is first divided in 2 conferences and those into up to 4 divisions. Teams seldom change because each league is a trade association financed by its 30 or 32 members. Teams play a divisional RR with many pairwise encounters as well as a number of inter-divisional games and an even smaller number of inter-conference games. On the basis of the winning percentage achieved at season's end, divisional top teams enter the "playoff" post-season and are joined by "wild-cards", the winners of matches between remaining best seeded teams in each conference, this to bring the playoff roster to either 8 or 16 teams. A knockout tournament then decides on the final champion.

In all 4 sports, seasonal games between two teams (up to 19 in baseball) are first coded with the chess score to create a virtual match whose outcome is the (Copeland) chess score i.e, if Ivan beats John 10 times while John beats Ivan 9 times, we record a (seasonal) win for Ivan. Using the number of such virtual matches played during the season, we can compute a winning percentage. The average over the entire period is shown in column "‰reg".

Playoff matches (to the best of 5 or 7 games) are awarded extra weight with 64 points for the final, 32 for the semi finals (conference finals) and 16 for the quarter finals. To gauge in simple fashion a team's success in the playoffs, we award 4 votes for the final, 2 for each semifinal and 1 for each quarterfinal (in each case to be collected by the match victor). With the proper scaling, a systematic winner of the "world series" would reap a perfect 1000 score in column "‰pl".

Because professional franchises involve fixed participants that regularly win against each other, there is an excellent network connectivity and also less stark differences than in (association) football where new weak teams enter the league every year.

Baseball is very demanding as teams plays no less than 160 games every year. In 2019, 2429 games were played in total, yielding 300 virtual matches out of a maximum 435 (if a full RR was organized among the 30 teams). As Table 10 reveals, the baseball league is quite competitive since most teams enjoy fairly high fitness and prestige; only the *Yankees* stand clearly at the top thanks to a string of excellent results in the early period.

Baseball 1970-2021	Fitness	Prestige	‰reg	‰pl
New York Yankees	924	1000	649	181
Boston Red Sox	806	785	609	102
Los Angeles Dodgers	646	768	614	106
St. Louis Cardinals	605	700	548	105
Oakland Athletics	655	698	554	85
Atlanta Braves	521	640	528	80
Houston Astros	528	595	519	56
Cincinnati Reds	604	592	528	64
San Francisco Giants	597	581	501	76
Philadelphia Phillies	493	544	490	59
New York Mets	531	539	487	45
Baltimore Orioles	504	535	505	55
Kansas City Royals	478	517	464	52
Detroit Tigers	477	505	473	39
Cleveland Indians	444	487	478	31
Los Angeles Angels	591	477	515	20
Minnesota Twins	485	468	469	36
Toronto Blue Jays	538	459	487	41
Pittsburgh Pirates	440	453	481	35
Chicago Cubs	458	443	478	29

Table 10: US Professional Baseball

Football involves only 17 games per team during the regular season, about an order of magnitude less than baseball. In 2019, 256 games were played during the season, yielding 208 matches out of a maximum 496 (if a full RR was organized among the 32 teams). As may be observed from Table 11, the *Steelers* and *Patriots* are the most prestigious teams as confirmed by their higher rate of achievement in playoffs.

Football 1970-2021	Fitness	Prestige	‰reg	‰pl
Pittsburgh Steelers	1000	1000	612	162
New England Patriots	954	982	568	173
Dallas Cowboys	907	941	574	147
San Francisco 49ers	828	892	539	147
Denver Broncos	798	783	570	107
New York Giants	911	713	471	93
Oakland Raiders	739	686	527	91
Green Bay Packers	714	682	535	77
Miami Dolphins	738	675	583	77
Washington FT	773	664	529	85
Los Angeles Rams	615	662	506	87
Philadelphia Eagles	625	599	515	58
Indianapolis Colts	632	593	500	67
Minnesota Vikings	518	571	555	51
Seattle Seahawks	637	526	520	51
Buffalo Bills	514	521	476	45
Kansas City Chiefs	587	510	510	41
Chicago Bears	572	499	489	38
Tennessee Titans	488	470	483	32
New Orleans Saints	566	450	476	32

Table 11: US Professional Football

Basketball involves 82 games per team during the regular season, a large figure in line with baseball. In 2019, 1230 games were played, yielding 435 matches as in a RR among the 30 teams although a team plays more inside his division and inside his conferences. The *Lakers* are the dominant team, being both fittest and most prestigious (as attested by their high scoring during the regular season and playoffs), the *Celtics* are a clear runner-up.

Basket 1970-2021	Fitness	Prestige	‰reg	‰pl
Los Angeles Lakers	1000	1000	635	311
Boston Celtics	717	746	595	175
San Antonio Spurs	836	685	639	157
Chicago Bulls	663	636	516	151
Detroit Pistons	557	590	491	112
Houston Rockets	571	555	541	88
Oklahoma City Thunder	514	542	546	74
Golden State Warriors	532	522	476	106
Phoenix Suns	494	521	543	62
Portland Trail Blazers	512	504	549	53
Milwaukee Bucks	498	494	540	64
New York Knicks	445	488	491	70
Utah Jazz	548	474	581	53
Philadelphia 76ers	431	472	491	63
Cleveland Cavaliers	421	465	451	76
Miami Heat	610	460	521	105
Indiana Pacers	423	404	504	42
Dallas Mavericks	483	401	505	48
Atlanta Hawks	384	399	486	27
Washington Wizards	375	396	455	39

Table 12: US Professional Basketball

The statistical treatment of hockey mimics baseball due to their similar season structure. In 2019, 1271 games were played during the season, yielding 465 matches, close to the RR upper bound of 496 among the 32 teams. *Canadiens* and *Bruins* top prestige thanks to their many Stanley Cups captured during the 1970s while *Flyers* owe their third position to 8 appearances in the final over a long stretch of time (when they meet and beat the Top2). Next team *Penguins* are a modern successful outfit. Many teams achieve high prestige because no one has been able to establish a long dominance, the championship title being widely distributed among all teams.

Hockey 1970-2021	Fitness	Prestige	‰reg	‰pl
Montreal Canadiens	1000	1000	608	175
Boston Bruins	700	875	622	119
Philadelphia Flyers	620	802	582	88
Pittsburgh Penguins	699	755	504	104
Detroit Red Wings	673	731	497	78
New York Islanders	643	721	502	101
New York Rangers	568	685	544	60
Edmonton Oilers	678	652	492	97
St. Louis Blues	589	621	516	38
New Jersey Devils	567	588	437	62
Washington Capitals	633	576	515	31
Chicago Blackhawks	660	550	504	64
Buffalo Sabres	490	546	508	17
Los Angeles Kings	516	546	454	43
Tampa Bay Lightning	747	537	471	77
Calgary Flames	618	535	518	32
Vancouver Canucks	442	487	442	18
Toronto Maple Leafs	402	471	465	3
Dallas Stars	675	439	548	35
Colorado Avalanche	702	420	561	38

Table 13: US Professional Hockey

As recalled by Keener (1993) and Park and Newman (2005), US college football remained for decades the only varsity sport not crowning a national champion in a post-season tournament, using instead two end-of-season polls, by sports writers and coaches respectively, to elicit a champion; this odd approach generated mayhem among fans whenever polls disagreed. More recently, a (mini Super Bowl) championship game was organized but the finalists selection was still subjective. Since it is impossible to run a round-robin for 120 teams over an academic season, teams are distributed among a dozen conferences to play a regional round-robin and a few games against teams from other conferences. This dearth of comparability (within a season) makes it almost impossible to objectively compare conferences's quality and therefore to incorporate the "strength of schedule" when trying to compare top teams across conferences.

We are nevertheless able to estimate prestige over a long period because there has been enough cross conferences matches to makes the large network irreducible. For instance, in 2019, there were 848 mostly intra conference seasonal games and 40 cross-conferences post-season games (weighted 4 times more as we did for all playoffs). As revealed by Table 12, the GOAT in college football is the *Crimson Tide* followed at some distance by *Trojans* and *Gators*.

1970-2021	Fitness	Prestige
Alabama (SEC)	1000	1000
USC Trojans (Pac12)	736	836
Florida Gators (SEC)	653	826
Georgia (SEC)	732	780
Oklahoma (Big12)	780	757
Ohio State (Big10)	741	754
Florida State (ACC)	672	740
Notre Dame (FBS)	615	735
Auburn (SEC)	597	734
Nebraska (Big10)	630	721
Michigan (Big10)	595	708
LSU Tigers (SEC)	547	692

1970-2021	Fitness	Prestige
Penn State (Big10)	609	660
Clemson (ACC)	521	642
Texas (Big12)	498	627
Tennessee (SEC)	503	620
UCLA (Pac12)	439	614
Miami (ACC)	496	611
Washington (Pac12)	402	562
Stanford (Pac12)	372	540
Oregon (Pac12)	344	504
Texas A&M (SEC)	358	495
Arizona State (Pac12)	370	492
Wisconsin (Big10)	338	475

Table 14: US College Football

Looking at the 1989 season reveals top strength for Notre-Dame (ranked second and third in the polls) and top fitness for Miami who was ranked first by both polls as well as Keener (1993) in his pioneering study. Looking at the entire 52 years periods, there are only 15 discrepancies between either of the official polls and our fitness concept, concentrated over the 1970s and 1980s.

1.3 Motor Racing

We study Formula 1, US IndyCar, Rally (WRC) and MotoGP where each race awards the same set of points to participants. To account for changes in the official point system, we distribute equivalent points for each race using the current one. We can then compute career scores (and select the Top200) as well as the ratio of equivalent points per race "pts(‰)" rescaled to 1000 for a perfect score (winning every race one has entered into). Lastly, we compute a smoothed curve of equivalent points per year for each racer to identify the peak of his career.

In Formula1, *L. Hamilton* is the clear dominant driver; his performance may be summarized by saying he had won 63% of all his races while scored nothing in the remaining ones. Other prestigious drivers are *A. Prost* (also with a strong "pts(‰)"), *N. Lauda* and *S. Vettel*; oddly enough, *M. Schumacher*, a seven times champion with a high ratio of points per race is somewhat left behind, possibly because the opposition at the time was weaker. Compared to other sports, Formula1 awards a lot of prestige to drivers from the faraway past.

1970-2021	Fitness	Prestige	pts(‰)	Peak
Lewis Hamilton	468	1000	629	2020
Alain Prost	493	898	566	1989
Niki Lauda	370	812	305	1978
Sebastian Vettel	259	742	469	2013
Nelson Piquet	247	647	315	1987
Emerson Fittipaldi	336	643	259	1975
Michael Schumacher	215	600	506	2004
Ayrton Senna	359	574	491	1992
Carlos Reutemann	263	509	330	1981
Fernando Alonso	127	509	343	2008
Jody Scheckter	325	491	303	1979
Nigel Mansell	183	463	309	1992
Alan Jones	271	434	381	1981
Jackie Stewart	1000	426	485	1973
Ronnie Peterson	235	407	224	1975
Kimi Räikkönen	91	404	318	2007
Mario Andretti	204	395	195	1979
Nico Rosberg	145	361	336	2016
James Hunt	272	342	257	1976

Table 15: Formula One World Championship

The US based IndyCar involves a dozen yearly races on large ovals tracks (a few miles long) using cars similar to Formula 1; our treatment is thus identical. New Zealander *S. Dixon* is the clear GOAT thanks to a long career, 6 championships and a high ratio of points per race. The runner-up is contemporary Australian *W. Power*, also markedly above the rest. As in motoGP, the prestige of these dominant drivers pulls up many millennials. Great drivers from the previous century are *M. Andretti* (son of a F1 champion), *B. Rahal* and *Al Unser Jr.* (son of an IndyCar past legend).

1970-2021	Fitness	Prestige	pts(‰)	Peak
Scott Dixon	511	1000	437	2012
Will Power	404	778	360	2014
Josef Newgarden	428	545	304	2021
Dario Franchitti	400	486	402	2012
Helio Castroneves	198	434	296	2012
Michael Andretti	247	415	348	1992
Simon Pagenaud	228	397	306	2020
Sébastien Bourdais	312	378	399	2007
Ryan Hunter-Reay	166	377	223	2015
Bobby Rahal	268	352	405	1982
Al Unser Jr	225	337	346	1994
Gil de Ferran	416	269	297	2001
Paul Tracy	135	267	300	2006
Jimmy Vasser	165	252	265	1998
Rick Mears	183	227	497	1982
Alex Zanardi	1000	223	346	1998
Juan Montoya	311	219	287	1999
Emerson Fittipaldi	187	206	392	1993
Tony Kanaan	78	200	226	2012

Table 16: IndyCar Championship

In rally WRC, 9-times champion *S. Loeb* unexpectedly tops both fitness and prestige but also pulls his adversaries *C. Sainz* and *M. Grönholm* above 4-times champion *T. Mäkinen* and recent 8-times champion *S. Ogier*. Even though the former pair only won the championship twice, they have beaten *S. Loeb* and *T. Mäkinen* many times in their long careers and therefore receive some of their prestige. The performance measure "pts(‰)" confirms that *S. Loeb* stands above the pack in terms of an uncanny ability to win 3 out of 4 races he enters into. As opposed to Formula 1, rally does not bestow much prestige to early drivers (peaking before 1990), likely because of much shorter careers and absence of domination by a single driver during those earlier decades.

1970-2021	Fitness	Prestige	pts(‰)	Peak
Sébastien Loeb	1000	1000	733	2008
Carlos Sainz	464	701	615	1994
Marcus Grönholm	582	646	638	2006
Tommi Mäkinen	677	612	595	2000
Sébastien Ogier	541	558	622	2017
Juha Kankkunen	413	534	615	1993
Petter Solberg	264	455	460	2006
Colin McRae	417	422	600	1998
Richard Burns	438	400	553	2003
Didier Auriol	339	385	519	1994
Jari-Matti Latvala	151	297	419	2015
Mikko Hirvonen	205	292	521	2012
Miki Biasion	312	244	656	1991
Thierry Neuville	202	224	499	2020
Markku Alén	159	200	641	1988
Ott Tänak	162	193	390	2021
Hannu Mikkola	194	190	680	1984
Gilles Panizzi	166	145	346	2003
Björn Waldegård	141	138	612	1979

Table 17: World Rally Championship

In MotoGP, *M. Márquez* a 6-times champion tops popular *V. Rossi*, a 7-times champion, thanks to a much greater fitness (and higher "pts(‰)" ratio) and a shorter career (for now). As opposed to Formula 1 and Rally, MotoGP concentrates prestige upon active pilots as may be seen by the presence of numerous racers with a peak after 2019; these are grabbing prestige from beating the still active *M. Márquez* and *V. Rossi* from time to time. The old-timers emerging in the Top20 are *W. Rayney*, *E. Lawson*, *K. Schwantz* and *M. Doohan*.

1970-2021	Fitness	Prestige	pts(‰)	Peak
Marc Marquez	1000	1000	678	2014
Valentino Rossi	223	793	596	2005
Jorge Lorenzo	388	775	572	2016
Dani Pedrosa	199	511	548	2014
Andrea Dovizioso	155	487	442	2019
Casey Stoner	317	335	627	2011
Maverick Viñales	161	266	391	2020
Wayne Rainey	368	203	758	1993
Eddie Lawson	180	196	689	1989
Kevin Schwantz	173	179	661	1993
Mick Doohan	206	177	786	1998
Joan Mir	269	174	389	2020
Cal Crutchlow	46	123	277	2019
Wayne Gardner	101	117	624	1990
Johann Zarco	68	87	295	2017
Freddie Spencer	126	84	637	1985
Nicky Hayden	25	80	321	2006
Randy Mamola	42	71	529	1987
Loris Capirossi	24	69	376	2007

Table 18: Grand Prix Motorcycle Racing

1.4 Tennis, Ski, Cycling & Golf

These individual sports are based on races or tournaments. Classified participants receive money and points (for a league contest). Money matter most in golf while points matter most in ski (to be crowned world-cup champion). Since tennis tournaments are KO, we already have the pairwise comparisons we need. Elsewhere, events are turned into pairwise comparisons using the pecking order described for motor racing (after selecting the Top20 of each event).

These 4 sports involve prestigious events which are the 4 majors in golf, the 4 grand slam in tennis, the 3 major country tours in cycling while for ski we have the bi-yearly world championships and the olympic games. Al of these are given 4 times more weight vs a regular event.

Radicchi (2011) has previously computed men prestige using a 15% random attribution "à la Google" over the period 1968–2010, finding *J. Connors*, *I. Lendl* and *J. McEnroe* at the top. Over the longer period 1970-2021, Table 19 shows that competition among men is dwarfed by the "truel" between *N. Djokovic*, *R. Nadal* and *R. Federer*, although the latter is now distanced as the formers keep dominating their sport. A typical feat of the prestige system is to allow *A. Murray*, a contemporary of the great trio, into the top even though he did not win as many titles as many of the older great players; notable one are *P. Sampras*, *A. Agassi* and *I. Lendl*.

1970-2021	Fitness	Prestige	pts(‰)	Peak
Novak Djokovic	927	1000	753	2015
Rafael Nadal	1000	954	765	2011
Roger Federer	655	868	726	2008
Andy Murray	416	360	630	2016
Pete Sampras	468	289	762	1997
Andre Agassi	286	252	681	2003
Ivan Lendl	233	238	695	1987
Stan Wawrinka	395	206	578	2017
Stefan Edberg	229	189	644	1991
Boris Becker	258	165	680	1990
Jimmy Connors	143	154	686	1978
John McEnroe	219	146	713	1984
Juan Martin del Potro	355	143	592	2013
Andy Roddick	203	122	595	2007
Lleyton Hewitt	227	121	608	2005
Mats Wilander	234	117	695	1988
Jim Courier	252	116	644	1995
Bjorn Borg	264	114	788	1980
Tomas Berdych	164	110	498	2016

Table 19: Male Tennis

The field is more diverse among women as may be appreciated in Table 20 where *S. Williams* barely tops "old-timer" *M. Navratilova*; the greater number of grand slams of the former seem to be toned down by a lower intense competition as the latter's direct adversaries *S. Graf* and *C. Evert* are adjacent in the ranking. Other greats are the second *Williams* sister and *M. Seles*. Similar to what happens in female skying, dominant current active players *S. Halep* and *A. Kerber* appear near the bottom of the table.

1970-2021	Fitness	Prestige	pts(‰)	Peak
Serena Williams	727	1000	770	2016
Martina Navratilova	359	996	766	1986
Steffi Graf	585	836	819	1991
Chris Evert	291	795	754	1977
Venus Williams	362	549	629	2002
Monica Seles	415	462	736	1993
Maria Sharapova	331	368	639	2015
Arantxa Sanchez Vicario	178	364	589	1996
Martina Hingis	333	356	672	2000
Lindsay Davenport	254	331	626	2000
Evonne Goolagong	184	327	721	1973
Victoria Azarenka	348	310	619	2013
Justine Henin	480	287	717	2007
Angelique Kerber	361	285	593	2018
Gabriela Sabatini	168	282	585	1992
Simona Halep	354	272	615	2019
Billie Jean King	234	267	745	1972
Kim Clijsters	329	226	640	2011
Margaret Court	441	224	852	1970

Table 20: Female Tennis

For alpine ski, we include races in the slalom, giant, super giant and downhill categories; since many skiers regularly engage in several modes, there is a great connectivity between the distinct championships. However, ancient data only records the first 10 classified in every race (vs thrice more in recent times); this tends to make early racers fitter than they really were as we do not see when they raced but failed get into the Top10. To balance epochs, we thus truncate all races to the Top10 which involves a loss of information; we are therefore less confident about our ski prestige ranking. As already mentioned, beyond the dozens races organized during the winter, the main events are the world championship and the olympics whose points are weighted 4 times more as we did for motor sports. Column "pts(‰)" indicates the average points (over 1000) gathers by a skier over his/her career.

Among male alpine skiers, the most prestigious are would be *H. Maier* by a very small margin over the very recently dominant *M. Hirscher*. Top fitness in turn belongs to *A. Tomba*, another powerful performer from an earlier epoch while technical *I. Stenmark* is the most prestigious arising from the early times, together with *M. Girardelli* and *P. Zurbriggen*. Note how the Top20 is mostly populated by racers from the last 3 decades.

1970-2022	Fitness	Prestige	pts(‰)	Peak
Hermann Maier	532	1000	275	2003
Marcel Hirscher	637	979	345	2019
Alberto Tomba	742	888	330	1996
Aksel-Lund Svindal	312	851	198	2014
Ingemar Stenmark	528	829	354	1982
Marc Girardelli	264	749	179	1989
Benjamin Raich	230	736	157	2009
Pirmin Zurbriggen	388	734	189	1989
Bode Miller	303	681	187	2006
Stephan Eberharter	386	674	224	2004
Ted Ligety	472	649	198	2015
Kjetil Andre Aamodt	150	586	84	1996
Kjetil Jansrud	348	567	186	2019
Didier Cuche	183	537	137	2012
Lasse Kjus	183	475	124	1999
Peter Mueller	382	452	213	1989
Michael Walchhofer	349	444	189	2007
Michael von Gruenigen	299	442	205	2001
Beat Feuz	315	432	185	2022

Table 21: Male Alpine Ski

Among female skiers, prestige mostly befall racers from the previous century with mixing among eras; *V. Schneider* comes slightly ahead of *A. Proell* with modern skier *L. Vonn* third. Oddly enough, the current dominant skier *M. Shiffrin* appears in the bottom half of the table, after *T. Maze* another highly successful skier. This oddity is due to the arch dominance of "old timer" *A. Proell* that bestows a lot of prestige towards the former century (because of the aforementioned data censoring). The contrast with men reminds us that prestige is a network concept, it may not be assessed for an individual performer but only for a large group of interconnected people and is furthermore sensitive to details not apparent at first glance.

1970-2022	Fitness	Prestige	pts(‰)	Peak
Vreni Schneider	876	1000	320	1991
Annemarie Proell	724	982	294	1975
Lindsey Vonn	405	787	314	2013
Hanni Wenzel	414	762	162	1982
Katja Seizinger	458	737	240	1998
Anja Paerson	328	716	202	2007
Maria Walliser	399	600	194	1990
Renate Goetschl	255	586	218	2003
Deborah Compagnoni	616	557	212	1998
Tina Maze	225	540	162	2015
Erika Hess	421	523	210	1985
Carole Merle	459	502	222	1993
Mikaela Shiffrin	317	497	332	2019
Pernilla Wiberg	291	494	184	1999
Michaela Dorfmeister	233	479	157	2006
Anita Wachter	210	468	148	1994
Marie Therese Nadig	393	460	187	1972
Lise Marie Morerod	1000	458	378	1978
Michela Figini	422	447	212	1989

Table 22: Female Alpine Ski

Cycling, mostly taking place in Europe, involves staged races and one-day events. The following ad-hoc prestige weights are applied: *Tour de France* (16), *Giro d'Italia* (12), *Vuelta a España* (8), *Paris-Nice* (4), *Tour du Dauphiné* (4), any other multi-stage (3), major one-day races (2), minor one-day races (1). We start from 50 annual events and select the 25 with most repetition throughout the period and weight. In accordance with official records, we remove the disgraced condemned and confessed doping master *L. Armstrong* (who would otherwise be second, bringing to the top some adjacent performers).

Table 23 overemphasizes the past century with low-heart-rate *M. Indurain* at the top; notable current cyclists are *C. Froome*, *A. Contador* and *A. Valverde*. Legend *E. Merckx* would certainly rank higher if a longer span had been considered. As in other sports, a few minor champions grab high ranks for being effective contemporaries of the most prestigious ones.

1970-2021	Fitness	Prestige	pts(‰)	Peak
Miguel Indurain	765	1000	722	1995
Bernard Hinault	1000	806	840	1985
Greg Lemond	609	711	572	1990
Alberto Contador	605	695	916	2011
Alejandro Valverde	261	647	507	2018
Chris Froome	527	611	779	2017
Sean Kelly	199	582	302	1988
Tony Rominger	368	532	486	1995
Laurent Fignon	404	521	508	1984
Claudio Chiappucci	196	491	325	1994
Eddy Merckx	647	467	775	1975
Francesco Moser	333	467	485	1979
Laurent Jalabert	249	467	328	1999
Joop Zoetemelk	157	443	440	1982
Gianni Bugno	168	437	236	1994
Alex Zülle	227	398	349	1999
Pedro Delgado	179	377	462	1992
Davide Rebellin	151	373	216	2008
Giuseppe Saronni	355	373	497	1983

Table 23: Road Cycling

For male professional golf, we first deal with the so-called major tournaments. As purse money rose at about 10% per year (vs less than 3% for inflation), the prizes awarded to players must be used with care. Using a stepwise exponential fit of prize money distribution in the 4 majors of 2021, we create a virtual point scale with a maximum of 1000 for the winner to compute equivalent points, select the Top20 in each tournament since 1970, compute yearly total points and take again the Top20 players so as to balance the number of performers across time (as there are more players today). Imposing presence over more than one year leaves us with 191 golfers. Next, we select the 16 most endowed events of the year so as to get a total of 20 yearly events which is about the average for motor races. Column "major(‰)" indicates the career long performance in the majors (with a theoretical maximum of 1000 for winning every major entered into).

The fittest and most prestigious player is by far *T. Woods*, followed at a distance by *P. Mickelson*. The most prestigious old-timers are *T. Watson*, *J. Nicklaus* and *G. Norman*. The ranking is again titled in favor of currently active golfers as may be checked by their peak year.

Golf 1970-2021	Fitness	Prestige	major(‰)	Peak
Tiger Woods	1000	1000	538	2003
Phil Mickelson	394	627	442	2008
Rory McIlroy	624	499	347	2016
Dustin Johnson	538	432	336	2020
Ernie Els	267	384	337	2004
Justin Rose	317	340	268	2015
Sergio Garcia	238	312	271	2009
Jim Furyk	217	310	260	2010
Vijay Singh	217	310	229	2008
Adam Scott	238	288	227	2013
Tom Watson	161	274	318	1983
Jason Day	418	268	391	2017
Jack Nicklaus	230	261	464	1975
Henrik Stenson	302	247	282	2017
Greg Norman	221	244	322	1997
Davis Love III	180	241	239	1999
Jordan Spieth	453	234	518	2015
Brooks Koepka	505	231	422	2021
Bubba Watson	351	219	494	2015

Table 24: Golf

1.5 British sports

The team sports of rugby and cricket were popularized by the British empire and have not expanded much beyond, thus limiting the pool of contending countries (as compared to football). In rugby, the Top5 dominates while for cricket there is only a small wedge between the Top3 and the rest.

1970-2021	Fitness	Prestige
All Blacks	1000	1000
Wallabies	515	854
Boks	756	728
England	342	594
Les Bleus	249	518
Wales	150	258
Ireland	144	208
Scotland	84	144
Los Pumas	74	115
Azzurri	25	37
Japan	41	23
Samoa	28	16

1970-2021	Fitness	Prestige
Australia	1000	1000
India	710	839
England	711	820
Pakistan	646	707
West Indies	615	695
South Africa	967	591
New Zealand	554	586
Sri Lanka	520	565
Zimbabwe	138	117
Bangladesh	169	105
Ireland	122	22
Afghanistan	135	16

Table 25: International Rugby & Cricket

1.6 Fighting

This experimental section comes last because professional boxing is even more anarchical than chess when it comes to organization; furthermore, champions (and commercial promoters) have developed a habit of fighting challengers on rare occasions (to maximize returns). This means that even within a single weight category (e.g., heavy), a renown fighter has fought less than two dozen major bouts during his pro career (and very few minor ones). This already makes it difficult to compute prestige; additionally, there are many weight categories to equalize chances which makes the search for a "pound-for-pound" (P4P) champion even more elusive (cf. Tennant et al. (2020)). Using a list of lineal championships in the 10 categories of major weight (out of 16), we collect major matches since 1970 and award 8 points to the victor (vs one for a minor victory). An additional practical difficulty is that lighter boxers are more active; we thus re-weight matches so that over the entire period, each category distributes the same number of points. The gain matrix we build for boxing is very sparse because our more than 23 thousand boxers have disputed less than 2.5 matches on average. To increase connectivity, we identify over 300 world title challengers who appeared in distinct weight categories and collect their matches. Combining with top boxers (in terms of accumulated points), we contemplate 400 boxers over solely 1300 bouts.

Our highly tentative prestige ranking includes the winning percentage instead of fitness as well as the P4P ranking established by specialist website *BoxRec*. Famed entrepreneur/boxer *F. Mayweather* does not make it to the top slot, whichever way we may tune parameters, having failed both Seneca and Pogba by winning "safe" matches against "second-rated" adversaries as opposed for instance to the bet against all odds of *M. Ali* challenging *G. Foreman* in 1974.

Boxing 1970-2021	Division	WP	Prestige	Peak	BoxRec
Julio Cesar Chavez	Super light	940	1000	1982	11
Bernard Hopkins	Middle	881	896	1994	4
Oscar De La Hoya	Welter	867	882	1993	12
Floyd Mayweather Jr	Welter	1000	842	1998	1
Pernell Whitaker	Welter	913	698	1989	28
Felix Trinidad	Welter	933	697	1990	15
Virgil Hill	Light heavy	879	666	1987	31
Evander Holyfield	Heavy	825	634	1989	13
Joe Calzaghe	Super middle	1000	618	1996	8
Manny Pacquiao	Welter	889	566	1995	7
Kostya Tszyu	Super light	941	563	1992	35
Roy Jones Jr	Light heavy	880	517	1990	10
Lennox Lewis	Heavy	955	510	1990	5
Shane Mosley	Light	836	505	1994	26
Timothy Bradley Jr	Super light	946	485	2006	33
Dariusz Michalczewski	Light heavy	960	456	1993	44
Thomas Hearns	Super welter	925	401	1979	16
Mike McCallum	Super welter	909	398	1981	17
Ray Leonard	Welter	925	364	1979	3
Marvelous Marvin Hagler	Middle	938	326	1984	2

Table 26: Pro Boxing (pound-for-pound)

The modern sport of *mixed martial arts* (MMA) is better organized than boxing with fewer concurrent promoters; we obtain both a higher match frequency and more fighters changing weight categories which creates a reasonable degree of connectedness within the grand fights network. Implementation proceeds as for boxing: from 25 thousand bouts, we select the best 200 performers (including enough category switchers) who have fought each other an average 11 times. The GOAT appears to be *S. Miocic*, also pulling high his successor *F. Ngannou*. Top ranked *G. St Pierre* by specialist website *FightMatrix* is a clear runner-up.

MMA 1996-2021	Division	WP	Prestige	FightMatrix
Stipe Miocic	Heavy	785	1000	10
Georges St. Pierre	Welter	809	741	1
Daniel Cormier	Lightheavy	766	591	31
Francis Ngannou	Heavy	709	492	41
Demetrious Johnson	Fly	767	473	7
Matt Serra	Welter	644	407	84
Jon Jones	Lightheavy	675	376	2
Dominick Cruz	Bantam	815	372	23
Anderson Silva	Middle	770	359	6
Fedor Emelianenko	Heavy	750	343	4
Henry Cejudo	Bantam	800	315	113
Alexandre Franca Nogueira	Feather	679	302	43
Bas Rutten	Heavy	926	302	34
Fabricio Werdum	Heavy	675	286	24
Jose Aldo	Feather	762	272	3
Michael Bisping	Middle	636	263	60
Alistair Overeem	Heavy	678	250	53
Chuck Liddell	Lightheavy	655	227	18
Luke Rockhold	Middle	759	207	59
Kamaru Usman	Welter	829	200	11

Table 27: Mixed Martial Arts (pound-for-pound)

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