

# A Comparative Survey of Officially Recognized International Sports Rating Systems

\*Raymond T Stefani

California State University, Long Beach

Stefani@csulb.edu

## Abstract

A comprehensive comparative survey is presented, covering official rating systems as published by internationally recognized sports federations. Mind sports and physical sports are both included. As of December 2009, competitions in 156 international sports are organized by sports federations recognized by the IOC, Sport Accord and by Wikipedia under "List of International Sport Federations". Of the 156 sports, 17 are combat sports in which opponents are in direct physical contact as in boxing and wrestling, 73 are independent sports in which contact is not allowed as in swimming and archery and 66 are object sports in which indirect contact is allowed while opponents attempt to control an object as in basketball and chess. Of the 156 sports, 59 sports have no rating system, two combat sports have a subjective rating system, 82 sports have an accumulative system in which points accrue non-decreasingly over some window of time, and 13 sports have an adjustive system in which a rating self adjusts based on the difference between some observed result and a prediction of that result based on past performance. For accumulative rating systems, features include converting results to points, ageing results more than one year old, and adjusting points for performance quality. Such systems are favoured by tournament organizers who want to encourage many top competitors to enter as for skiing and tennis. The adjustive systems include Elo, probit and averaging methods. These systems are favoured for their technical sophistication by sports such as chess, draughts, go, cricket, and women's soccer. This study thus examines the observed practical methods used by the various sports federations to provide acceptable comparative ratings.

*Keywords:* Sports, rating systems, Olympics, international sports federations, ELO, probit

---

## 1. INTRODUCTION

This paper intends to offer a comprehensive overview of officially recognized international sports and the various rating systems for those same sports, as published by the sports federations which organize competition. It is well beyond the scope of this paper to survey previous contributions spanning the agenda. There are many excellent reference books and almanacs listing various types of sports, the history of each, rules and past results. Similarly, many specific types of rating systems have been offered in the literature from simple to complex, operating only on game score or applying regression to many game statistics. A selected list of important international sports ratings systems appears in Stefani (1997). In Stefani (1998), 83 widely played sports are selected based on International Olympic Committee recognition and on additional personally-selected sports that appeared to be widely played. A taxonomy of some of those sports is offered in Stefani (1999), using systems methods for categorization. In this paper, the number of analysed sports will be almost doubled. The 156 selected sports are those for which competition is organized by international federations, which are recognized by three definitive agencies.

The rest of this paper is organized as follows. Section 2 covers 156 sports of the world, providing a unifying taxonomy. It will be noted that many of the categorizations will be in sets of three. Section 3 provides a critical survey of the three basic types of ratings systems, provided by governing sports federations. This section is intended to be a resource for those wanting to create a rating system. The reader will have guidance into the basics of creating each type of system. Section 4 will provide conclusions.

## 2. SPORTS OF THE WORLD

To begin, what is a sport? I will generalize the usual dictionary definition; so as to be inclusive, not having to disqualify some widely recognized competitions. I define a sport as a competition using established rules for determining the winner. Sports so defined fall into two classes. In a mind sport, a surrogate (human, mechanical or computer) can make a play for the competitor as in chess and bridge. No physical action is need. For example, chess has been contested with moves sent via computer or by mail. In a physical sport, the competitor must make each play, requiring physical prowess as in running and soccer. What I call a physical sport follows the more widely used dictionary definition of a sport. It should be noted that the first Mind Sports Games were contested in Beijing following the Beijing Olympics for chess, bridge, draughts (checkers), Go and Xianggi (Chinese Checkers). I suggest that the world of sports has plenty of room for both mind and physical sports.

### *Categories of Sports*

The *Official World Encyclopedia of Sports and Games* (1979) lists 15 categories of what are therein called games (mind sports here) and 13 categories of what are called sports therein (physical sports here). For example, some physical sport categories are court sports, team sports, water sports and stick and ball sports. Note that those categories are hardly mutually exclusive. For compactness henceforth, physical sports will not be distinguished from mind sports. I suggest with the certainty of physics, that there are three categories of sports following the three ways that two objects (competitors) can interact in three dimensional space without merging. First, in a combat sport competitors are in direct contact: the goal of a competitor is to control the opponent as in wrestling and boxing. Second, in an independent sport no significant contact between competitors is allowed as in running swimming and shooting: the goal is for the competitor to control his or her own self. Third, in an object sport the competitors interact indirectly as in soccer, chess and rugby: the goal is to control an object.

### *Recognized International Sports*

As mentioned earlier, the purpose of this paper is to select sports with wide international recognition and to survey the rating systems published by the relevant sports federations. Three sources of recognition are chosen herein. It was necessary to visit the website of each recognized federation to locate all sports organized by each federation. It was necessary to distinguish a sport (swimming, athletics) from a discipline within that sport (butterfly, pole vault) and only count sports. First, the International Olympic Committee, IOC, is obviously a world leader in sport; however, the IOC uses non-standard terminology as to the term "sport" in that "sport" and "international sports federation" are used interchangeably. (Due to the very large number of federation abbreviations to follow, the reader is directed to the appropriate website for each definition.) For example, aquatics is considered to be one sport due to the one federation, FINA, which organizes competition in what the IOC calls four "disciplines", swimming, diving, water polo and synchronized swimming, which in common terminology would be considered to be four sports. Henceforth, this paper will use the term "sports federation" for what the IOC calls a sport and will use the term "sport" for what the IOC calls a discipline. As of December 2009, the IOC website [www.olympic.org](http://www.olympic.org) recognized the numbers of sports federations and sports for Summer Olympic, Winter Olympic non-Olympic competitions as shown in Table 1.

The sports are broken down into combat, independent and object categories. The Vancouver Olympic website provided 15 icons, one each for the 15 recognized sports while it would be expected that a website for the upcoming London Games of 2012 would have 37 icons. In addition to the 52 Olympic sports, another 54 non-Olympic sports are recognized. Table 2 will be discussed in relation to rating systems. Tables 3-5 contain the combat, independent and object sports respectively for which the governing international federation publishes a rating system..

Table 1: International Sports Federations and Sports

Recognition	Sports Federations	Sports	Combat	Independent	Object
IOC Summer	26	37	6	21	10
IOC Winter	7	15	0	13	2
IOC Recognized	34	54	3	23	28
Total IOC	67	106	9	57	40
Sport Accord (additional)	21	25	6	10	9
Other (Wikipedia)	24	25	2	6	17
Total Additional	45	50	8	16	26
Total	112	156	17	73	66

Table 2: Types of Sports Rating Systems

Sport	Number	Type of Sports Rating System			
		Accumulative	Adjustive	Subjective	None
Table 4 Combat Sports	17	3	1	2	11
Table 5 Independent Sports	73	51	3	0	19
Table 6 Object Sports	66	28	9	0	29
Total	156	82	13	2	59

Table 3: International Rating Systems for 6 of the 17 Combat Sports

Sport	Int. Fed.	Recognition	Type of Rating System	Years for Accumulative System
Boxing	AIBA	IOC Summer	Accumulative	4
Fencing	FIE	IOC Summer	Accumulative	1
Judo	IJF	IOC Summer	Accumulative	2
Kickboxing	WKF, WAKO	Sport Accord	Subjective	
Mixed Martial Arts	ISCF	Wikipedia	Subjective	
Sumo Wrestling	ISF	IOC Recognized	Adjustive ELO	

The second source of recognition is the international organization Sport Accord, which recognizes all IOC-recognized federations as well as an additional 21 federations organizing 25 additional sports, See the References section for the web link.

The third source of recognition is Wikipedia. As of December 2009, Wikipedia had organized coverage of international sports federations (as in this paper) into IOC-recognized federations, additional Sport Accord recognized federations and another 24 federations organizing 25 sports. The Wikipedia website provides convenient links to all sports included here, although some links do not work and some sports are not in the correct branch of the IOC-Sport Accord-Wikipedia trilogy. See the References section for the web link. Table 1 includes 156 sports, 2/3 of which are IOC recognized. About 10% (17) of these are combat sports while the remaining 90% of the sports are about evenly distributed among 73 independent sports and 66 object sports. Sport Accord and Wikipedia also include a number of federations that organize social meetings, organize international competitions for the other sports and organize sports for separately-abled athletes. Such sports are not included here.

Table 4: International Rating Systems for 54 of the 73 Independent Sports  
*Year = the number of years included for an accumulative system*

Sport	Int. Fed.	Recognition	Type of Rating System	Years for Accumulative System
Airsoft Practical Shooting	IAPS	Wikipedia	Accumulative	2
Alpine Skiing	FIS	IOC Winter	Accumulative	1
Athletics(Track and Field)	IAAF	IOC Summer	Accumulative	1
Auto Racing	FIA	Wikipedia	Accumulative	1
Biathlon	IBU	IOC Winter	Accumulative	1
BMX cycling	ICU	IOC Summer	Accumulative	1
Bobsled	FIBT	IOC Winter	Accumulative	1
Bowling	FIQ	IOC Recognized	Accumulative	1
Canoe	ICF	IOC Summer	Accumulative	1
Cross County Skiing	FIS	IOC Winter	Accumulative	1
Cycling-road	ICU	IOC Summer	Accumulative	1
Cycling-Track	ICU	IOC Summer	Accumulative	1
Dance Sport	IDSF	IOC Recognized	Accumulative	1
Darts	WDF	Sport Accord	Accumulative	2
Diving	FINA	IOC Summer	Accumulative	1
Equestrian	FEI	IOC Summer	Accumulative	1
Figure Skating	ISU	IOC Winter	Accumulative	2
Freestyle Frisebee	WFDF	Sport Accord	Accumulative	1
Freestyle Skiing	FIS	IOC Winter	Accumulative	1
Glider Racing	FAI	IOC Recognized	Accumulative	3
Gymnastics	FIG	IOC Summer	Accumulative	1
Hang Gliding	FAI	IOC Recognized	Accumulative	3
Ice Climbing	UIAA	IOC Recognized	Accumulative	1
Kayak	ICF	IOC Summer	Accumulative	1
Luge	FIL	IOC Winter	Accumulative	1
Minigolf	WMF	Sport Accord	Accumulative	3
Modern Pentathlon	UIPM	IOC Summer	Accumulative	1
Motorcycle Racing	FIM	IOC Recognized	Accumulative	1
Mountain Bike Cycling	ICU	IOC Summer	Accumulative	1
Nordic Combined	FIS	IOC Winter	Accumulative	1
Orienteering	IOF	IOC Recognized	Accumulative	1
Power Boating	UIM	IOC Recognized	Accumulative	1
Powerlifting	IPF	Sport Accord	Accumulative	1
Rhythmic Gymnastics	FIG	IOC Summer	Accumulative	4
Rowing	FISA	IOC Summer	Accumulative	1
Sailing	ISAF	IOC Summer	Accumulative	2
Shooting	ISSF	IOC Summer	Accumulative	2
Short Track Speed Skating	ISU	IOC Winter	Accumulative	1
Skeleton Sled	FIBT	IOC Winter	Accumulative	1
Ski Jumping	FIS	IOC Winter	Accumulative	1
Ski mountaineering	UIAA	IOC Recognized	Accumulative	2
Sled Dog Racing	IFSS	Sport Accord	Accumulative	1
Snowboarding	FIS	IOC Winter	Accumulative	1
Speed Skating	ISU	IOC Winter	Accumulative	1
Sport Climbing	UIAA	IOC Recognized	Accumulative	1
Surfing	ISA	IOC Recognized	Accumulative	1
Swimming	FINA	IOC Summer	Accumulative	1

Trampoline	FIG	IOC Summer	Accumulative	4
Triathlon	ITU	IOC Summer	Accumulative	2
Water Skiing	IWSF	IOC Recognized	Accumulative	1
Weightlifting	IWF	IOC Summer	Accumulative	1
Archery	FITA	IOC Summer	Adjustive	
Frisbee Golf	WFDF	Sport Accord	Adjustive	
Golf	IGF	IOC Recognized	Adjustive	

### 3. SPORTS RATING SYSTEMS FOR THE WORLD SPORTS

It is important to distinguish a rating from a ranking. A rating is a numerical value assigned to a competitor, based on results and other factors while a ranking is the ordinal placement based on the ratings. The federation websites for all 156 sports were carefully searched for rating systems. In many cases, an existing system was not easily located by information on the home page; however, a subsequent search via Google did locate an existing system. In each case, data over some fixed period are analysed sequentially to establish the ratings. As has been true of other taxonomies, sports rating systems may be separated into three mutually exclusive types, depending on how new ratings are arrived at for each update over the data window. Ratings are either subjective; objective-non-decreasing (called accumulative here) or objective-able to increase, decrease or remain the same (called adjustive here). The adjustive rating systems usually tend to be the best predictors of future performance since each adjustment follows from a predictor-corrector action; hence predictability is built in. Accumulative systems are preferred by many tournament-rich sports because the accumulation of points requires top athletes to enter as many tournaments as possible, which encourages ticket sales and TV revenue.

Table 2 contains the result of the survey of sports rating systems. Federations for 59 sports do not publish ratings. Of the 97 published rating systems, only two are subjective, 82 are accumulative and 13 are adjustive. It is clear that accumulative systems are favoured. Note that most accumulative systems are for independent sports (where performance is separate), most adjustive systems are for object sports (where performance should be adjusted for the opponent) and all subjective systems are for combat sports (where judges generally select the winner). The type of rating system tends to match the type of competition.

Table 3 (6 rating systems for the 17 combat sports), Table 4 (54 rating systems for the 73 independent sports) and Table 5 (37 rating systems for the 66 object sports) show the federation for each sport, the source of recognition, the type of rating system and the number of years in the data window used by each accumulative system. Table 5 identifies true team sports among the object sports. Each type of rating system is now covered in detail.

#### *Subjective Rating Systems*

The only two subjective systems are for WACO Kickboxing and the ICSF Mixed Martial Arts. A panel of experts ranks competitors and those individual rankings are combined for the overall ranking. There are also non-internationally recognized systems in boxing published by the WBC, WBA, IBF and WBO organizations and in UFC mixed martial arts, each of which employs a champion-challenger system rather than international tournaments.

There is one anomaly of this accounting system in that the Muay Thai federation does not publish Muay Thai ratings. The WKF Kickboxing federation publishes ratings for the Kickboxing events that WKF organizes and WKF also publishes Muay Thai ratings as a service to Muay Thai, although Muay Thai competition is organized by IFNA.

Table 5: International Rating Systems for 37 of 66 Object Sports  
*Year = the number of years included for an accumulative system*

Sport	Int. Fed.	Recognition	Team Sport	Type of Rating System	Years for Accumulative System
Badminton	BWF	IOC Summer		Accumulative	1
Baseball	IBAF	IOC Recognized	Team	Accumulative	4
Basketball	FIBA	IOC Summer	Team	Accumulative	8

Beach Volleyball	FIVB	IOC Summer	Team	Accumulative	1
Bridge	WBF	IOC Recognized		Accumulative	8
Carom Billiards	WCBS,UMB	IOC Recognized		Accumulative	2
Court Handball	USHA	Wikipedia		Accumulative	1
Curling	WCF	IOC Winter		Accumulative	7
Double Disc Court Frisbee	WFDF	Sport Accord		Accumulative	1
Field Hockey	FIH	IOC Summer	Team	Accumulative	4
Guts Frisbee	WFDF	Sport Accord	Team	Accumulative	1
Ice Hockey	IIHF	IOC Winter	Team	Accumulative	4
Korfball	IKF	IOC Recognized	Team	Accumulative	4
Lawn Bowls	CMSB, World Bowls LTD	IOC Recognized		Accumulative	4
Pool	WCBS,WPW	IOC Recognized		Accumulative	1
Racketlon	FIT	Wikipedia		Accumulative	2
Racquetball	IRF, IRT	IOC Recognized		Accumulative	1
Real Tennis	IRTPA	Wikipedia		Accumulative	1
Rugby Fives	RFA	Wikipedia		Accumulative	1
Rugby Sevens	IRB	IOC Recognized	Team	Accumulative	1
Snooker	WCBS WPSBA	IOC Recognized		Accumulative	2
Soft Tennis	ISTF	Sport Accord		Accumulative	1
Table Hockey	ITHF	Wikipedia		Accumulative	2
Table Soccer	ITSF	Wikipedia		Accumulative	1
Table Tennis	ITTF	IOC Summer		Accumulative	4
Tennis	ITF, ATP(M) WTA(W)	IOC Summer		Accumulative	4 1 1
Ultimate Frisbee	WFDF	Sport Accord	Team	Accumulative	1
Volleyball	FIVB	IOC Summer	Team	Accumulative	4
Chess	FIDE	IOC Recognized		Adjustive ELO	
Cricket	ICC	IOC Recognized	Team	Adjustive	
Croquet	WCF	Wikipedia		Adjustive ELO	
Draughts	FMJD	Sport Accord		Adjustive ELO	
Go	IGF, EGF	Sport Accord		Adjustive ELO	
Netball	IFNA	IOC Recognized	Team	Adjustive, similar to ICC	
Rugby Union	IRB	IOC Recognized	Team	Adjustive	
Soccer	FIFA	IOC Summer	Team	Adjustive (M) Adjustive ELO (W)	
Squash	WSF PSA(M) WISPA(W)	IOC Recognized		Adjustive	

### Accumulative Rating Systems

An accumulative rating system for competitor  $i$  follows the form shown in (1), where summation is over a window of past results for competitor  $i$ .

$$\text{New rating for } i = \sum f_i(\text{results, weights, ageing, old ratings, other factors}) \quad (1)$$

The function  $f_i$  in (1) includes converting results for competitor  $i$  to points, weighting points by importance, ageing data from previous years, including old ratings and other factors. The term “accumulative” follows

from the fact that all  $f_i(.) \geq 0$ , hence the running sum ratings for each  $i$  are non-decreasing as summation moves over the data window. A particularly simple accumulative system employs the “best” operator for the function  $f_i$ . For example, the current year’s best result is used by IAAF athletics and FINA swimming while the three best results of the current year are used by FINA diving.

Two distinctly different methods are employed to convert results to points weighted by importance. In FIVB Basketball, the various championships held over the eight-year window are each given a vector of weights varying from 5 to 0.1. Placement in each championship is given a common set of points from 50-1. It is necessary to multiply the weight by the placement points for a given competition. Conversely, for ATP (men’s professional) Tennis and WTA (women’s professional) Tennis, a matrix is published where each row contain result-scores for a given championship (say for Wimbledon) while each column contains the placement scores (for say, being eliminated in the quarter-finals). The matrix approach is recommended since both athlete and sports follower can easily denote the points to be accumulated for a given placement in a given championship. Table 6 shows the number of data-window years used by the 83 accumulative systems. Notice that a one year window is the most frequent data window, clearly favoured by the independent sports in Table 4 and by the individual (non-team) object sports in Table 5, where the skill of an individual can change rather dramatically from year to year. The number of systems drops for two and three year windows and increases for four year windows, which usually include one world cup and/or Olympic cycle. Multiple-year windows are favoured by the team object sports in Table 5, where a team may play a limited number of international matches in a given year requiring a number of years for valid comparisons.

Table 6: Number of Years for the 83 Accumulative Systems.

Number of Years	Systems
1	53
2	12
3	3
4	11
7	1 (Curling)
8	2 (Basketball, Bridge)

When there is a multiple-year window, the previous year’s results (relative to the current year) may be “aged” by multiplying the current year’s results by 100% and by multiplying each previous year’s results by a lower value.

Table 7: Ageing of Data

*Uniform ageing: IIHF Ice Hockey, IKF Korfball,  
ITF Tennis, FIH Field Hockey, ITTF Table Tennis.  
Non uniform ageing: FIVB Volleyball*

Year	Uniform Ageing	Non Uniform Ageing FIVB Volleyball	
		4 year events	2 year events
	All Points	4 year events	2 year events
1	100%	100%	100%
2	75%	75%	50%
3	50%	50%	0
4	25%	25%	
5	0	0	

Table 7 shows two methods used to age data. Ageing occurs over a four-year window for five sports with all events in a given year being aged exactly the same way, with a graduated ageing that drops by the same

fraction each year. Conversely, FIVB volleyball employs non-uniform ageing in that some event results are aged differently than others contested in the same year, depending on the frequency of the event.

IDF Darts is the only accumulative system using money won. In some sports, the final position value is multiplied by values dependent on other factors for that sport. In FAI Hang Gliding and Paragliding, other factors include the quality of entrants, the number of entrants, the relative time and the number of skills used. In ISAF Sailing, other factors include the importance of the race and the quality of entrants. In ISSF Shooting, other factors include the importance of the match, the score relative to the world record and the score relative to minimum standards. In IFSS Sled Dog racing, points are earned based on the length of race, the importance of the race and relative time. In ITU Triathlon, a bonus is given based on the number of top 20 entrants; however, no points are earned if the final time is worse than a cut off time.

### Adjustive Rating Systems

An adjustive rating system for competitor  $i$  has the form shown in (2).

$$\text{new rating for } i = \text{old rating for } i + K [\text{new result} - \text{prediction} (\text{old results, weights, old ratings})] \quad (2)$$

This type of rating system follows the format of a predictor-corrector in which a rating for  $i$  can increase, stay the same or decrease as each new result is compared to each prediction based on information available prior to the competition. The value of  $K$  must be chosen carefully. Too large of a value for  $K$  would make the ratings respond too forcefully to the error term in the square brackets [...], probably making ratings oscillate thereafter while too small of a value for  $K$  would make the ratings unresponsive to [...].

Table 8: Types of Adjustive Systems

Type	New Result	Prediction
Elo (6)	(1, .5, 0)	$P(d)$
Probit (3)	(1, 0, -1)	$k d$ with limiting
Averaging (4)	Chosen values	Past average of chosen values

According to Table 2, there are 13 adjustive systems published by the federations listed in Tables 3-5. In Table 8, these adjustive systems fall into another trilogy of categories, based on how the new result is used to make adjustments vis-a-vis the method used to predict each result. Let team  $i$ 's most recent opponent be designated  $j$ . Let  $d$  represent the rating difference between the ratings of competitors  $i$  and  $j$  prior to the most recent competition, as given by (3).

$$d = \text{old rating for } i - \text{old rating for } j \quad (3)$$

Six sports are rated using the Elo system, three are rated using Probit systems while four sports employ averaging methods. Each type is now covered in order.

### Elo Rating Systems

A strong point of the Elo system is simplicity, in that the system depends more on theory than on ad-hoc parameter selection. For the Elo System

$$P(d) = 1 / (1 + 10^{-d/[2 \sigma_i]}) \quad (4)$$

Here  $\sigma_i$  denotes the standard deviation of team performance, usually set at 200 arbitrarily while the mean is also set arbitrarily. The adjustive mechanism causes the rating distribution to follow whatever mean and standard deviation are selected. Only  $K$  must be selected purposely. It may seem illogical to use a base 10 exponent rather than a base  $e$  exponent. Actually, (4) is an approximation to a base  $e$  function.

The “new result” for the Elo system follows the scale (1 = a win, .5 = a draw and 0 = a loss) for competitor  $i$  against opponent  $j$ , which is compared to the a priori probability  $P(d)$ . The rightmost adjustment term in (2) becomes  $K [w - P(d)]$  where  $w$  is the new result. The maximum positive adjustment is  $K [1-0]$  or  $K$ . The ELO system was developed by Chess Master Arpad Elo. That system is used for six very diverse sports: FIDE Chess, FMJD Draughts (Checkers), WCF Croquet, IGF Go, FIFA Women’s Soccer and ISF Sumo Wrestling. Three applications are to mind sports and three are to physical sports.

For each of the six Elo applications, Table 9 shows the value of assumed team standard deviation and the range of  $K$  values. In order to compare the systems, the rightmost column shows the maximum rating change divided by the team standard deviation, which equals  $K$  divided by  $\sigma_t$ . The last column of Table 9 thus measures the sensitivity of the rating system. Where  $K$  has a range of values, the maximum rating change also has a range of values.

Table 9: Six Elo Rating Systems

Sport	$\sigma_t$	K	[Max. rating change K ] / $\sigma_t$
FIDE Chess, FMJD Draughts	200	10-25	.05 - .12
IGF Go	70-200	10 - 116	.14-.58
ISF Sumo Wrestling	$\geq 200$	$\geq 50$	.25 - .45
FIFA Women’s Soccer	200	10 – 40	.05 - .20
WCF Croquet	250	50	.20

For the mind sports of Chess, Draughts and Go as well as for the physical sport of Sumo Wrestling, the smallest maximum rating change is for a grand master while the largest maximum rating change is for a beginner. In such sports, it is logical that a newcomer wants to move up quickly while a grand master wants to remain highly rated; hence such rating sensitivities appeal to both competitors and meet directors. Conversely for Women’s Soccer, the smallest maximum rating change is for a friendly while the largest maximum rating change is for a World Cup final, as is reasonable for that sport. For croquet all competitors are subject to the same maximum rating adjustment. The most sophisticated selection of  $K$  is done for Sumo Wrestling, in that the other sports employ ad-hoc values of  $K$  while Sumo Wrestling employs a theoretically-derived formula. A rating system designed to facilitate accurate predictions would not be behold to competitors or meet directors and would treat highly-rated and lower-rated competitors with the same adjustment mechanism.

### Probit Rating Systems

For the three Probit adjustive systems in Table 10, the predicted probability of a win is a linear function  $k d$ , limited to a range such as +1 to -1. The new result is then evaluated for competitor  $i$  as (1 = a win, 0 = a draw and -1 = a loss). The adjustment term in Equation 2 become  $K [w - k d]$  where  $w$  is the new result. The maximum positive adjustment is  $K [1 - (-1)]$  or  $2 K$ . For each Probit system, Table 10 summarizes the value of the match prediction  $k d$ , the ratings smoother  $K$ , home advantage and the maximum change in terms of team standard deviations so as to compare with the Elo systems of Table 9.

The ICC Cricket and IFNA Netball systems are identical, both having been developed by David Kendix. Here prediction is given by  $d/50$  and  $K$  depends on the number of games played.

For IRB Rugby, prediction is given by  $d/10$  and 3 rating points are added to  $d$  for a home advantage if  $i$  plays at home. As compared to the FIFA Elo Women’s Soccer which adds uses 100 rating points to  $d$  as home advantage, the assumed fraction of home wins for  $d = 0$  is about the same (65% for Rugby and 64% for soccer). The maximum change for Cricket is the same as the maximum rating change for Rugby using a window  $n$  of about 10.

The IRB Rugby system is at the upper range of sensitivities compare to the Elo systems of Table 9. Note that the IRB Rugby system is the only one using score difference as a factor in determining  $K$ , which also depends on match importance. Since the inclusion of score provides more information than just winning, this IRB Rugby is recommended as an excellent example of a Probit system.

#### Averaging Systems

In an averaging system, a new result is compared with a past average of that same result, causing rating adjustment in (2). Five sports use averaging systems. In FIJA Archery, each score is adjusted for the cohort tournament average compared with the last cohort World Cup average and the scores are averaged over one year (minimum of 3) matches. In WFDF Frisbee Golf, a score more than two standard deviations from the mean is not used. The last eight scores are averaged. In IGF Golf, points are accrued depending on tournament placement and a two-year average is used (minimum of 40 tournaments). In WSF Squash tournament points are averaged over one year (minimum of 10 matches). For a Men's Soccer match, FIFA multiplies factors which depend on importance, continent, outcome and opponent rating, Ratings follow using a four-year weighted average.

Table 10: Three Probit Rating Systems (FIFA Elo is shown for comparative purposes)

Sport	Prediction $k d$	$K$	Home Adv.	Home Wins	[Max rating change $2 K$ ] / $\sigma_t$
ICC Cricket IFNA Netball (David Kendix)	d/50 with limiting	50/n n = games played	0		3.4 / n
IRB Rugby	d/10 with limiting	1-3 (win margin, importance)	3	65%	.13 - .38
(FIFA Elo Wom. Soccer)			100	64%	

#### 4. CONCLUSIONS

Based on three sources of recognition, 156 widely played international sports were identified, 17 of which are combat sports, 73 are independent sports and 66 are object sports. The organizing sports federations published rating systems for 97 of those sports, only two of which are subjective. Among the 82 accumulative systems, several convert performance points via a very compact and useful placement-importance matrix. A one year window is commonly used for individual independent and object sports; a four-year window is commonly used for team object sports and ageing is may be done uniformly in equal steps for all points earned in a given year. Of the adjustive systems, the Elo system is noted for its simplicity while the IRB Rugby Probit system is particularly well structured. The nine Elo and Probit adjustive systems had a maximum rating adjustment that varied from about 0.1 to 0.6 team standard deviations.

#### References

- Sport Accord International Sports Federations: <http://www.sportaccord.com/en/>..  
 IOC Recognized International Sports Federations: <http://www.olympic.org/en/content/The-IOC/>  
 Stefani, R. (1997) Survey of the Major World Sports Rating Systems, *Journal of Applied Statistics*, 24, 635-646.  
 Stefani, R. (1998) Predicting Outcomes. *Statistics in Sport*, Arnold Press.  
 Stefani, R. (1999) A Taxonomy of Sports Rating Systems. *IEEE Trans. On Systems, Man and Cybernetics, Part A*, 29, 116-120.  
*The Official Encyclopedia of Sports and Games*, New York, London: Paddington Press, 1979.  
 Wikipedia List of International Sports Federations [http://en.wikipedia.org/wiki/List\\_of\\_international\\_sport\\_federations](http://en.wikipedia.org/wiki/List_of_international_sport_federations):