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MTHD – 001

Prize Distribution, Round Robin

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1. **Overview**

This document specifies a method for distributing prizes in a division-less round robin style tournament, requiring only a skill-bias exponent and minimum prize threshold.

2. **Formulation**

The prize fraction awarded to any one player shall conform to the below equation:

$$f_i = \frac{max[0,(W_i - L_i)]E_i^{\gamma}}{\sum_{i=1}^{n} max[0,(W_i - L_i)]E_i^{\gamma}} \tag{1}$$

Where f_i is the prize fraction allocated to a particular player, E_i is the tournament-elo of that player, γ is the skill-bias exponent, W_i is the total number of wins accumulated by the player, including wins for un-played games awarded by admin. decision, L_i is the number of admin, losses (losses awarded only by admin. decision), and n is the number of prize-eligible players.

The presence a “max” function ensures that no numerator or contributor to the denominator may be negative; in the case that an uncommitted tournament player gives out more admin wins than games won, the smallest prize-proportion they could earn would be zero.

The fractions f_i , as calculated through Equation (1), are accumulated as entries in a *vector* called $\vec{f}$, of length n (number of prize-eligible players), and the sum of these components must equal 1. To obtain the prize distribution among players, $\vec{f}$ is simply multiplied by the total prize-pool.

Finally, it should be noted that tournaments reliant on this specification will define a threshold, below which prizes will not be awarded, or will state that prizes will be awarded to the top X players, etc. Practical limitations in online banking include transaction fees that might exceed the value of the prize, or represent an unacceptable proportion of it; E. G. a $3 transaction fee for a $5 prize. In that case, players not meeting this threshold will be eliminated one-by-one (starting with lowest earners) from the calculation, and it will be repeated to distribute their negligible earnings among the remaining participants.

3. **Example**

Tournament Prize Distribution: *A round-robin tournament has $100 in prize money, skill bias exponent of 3, and does not pay out winnings less than $15. The data on its five participants is summarized in Table 1 below:*

Name	**Tournament Elo**	**Total Wins**	**Admin Losses**
Player1	1900	8	1
Player2	1800	7	5
Player3	1500	6	1
Player4	1200	3	4
Player5	1000	5	0

Table 1: Results from a Round Robin Tournament

Calculate the prizes awarded to each player.

A second table is shown below to organize the calculation:

Name	Total Wins – Admin Losses	Elo Cubed	Fraction Numerator
Player1	$8-1=7$	$1900^3=6.86(10)^9$	$7(6.86)(10)^9=4.80(10)^{10}$
Player2	$7-5=2$	$1800^3=5.85(10)^9$	$2(5.83)(10)^9=1.17(10)^{10}$
Player3	$6-1=5$	$1500^3=3.38(10)^9$	$5(3.38)(10)^9=1.69(10)^{10}$
Player4	$3-4=-1$	$1200^3=1.73(10)^9$	$0(1.73)(10)^9=0$
Player5	$5-0=5$	$1000^3=1.00(10)^9$	$5(1.00)(10)^9=0.50(10)^{10}$

Table 2: Some Calculations From Sample Round Robin Tournament

The "Fraction Numerators" of Table 2 will always be true, regardless of threshold winnings payout, and are therefore worth quoting. Inspection of Table 2 immediately reveals that "Player4" will not receive any prize money because admin losses exceeded wins. For the remaining players, prize winnings are calculated by dividing the sum of all numerators into each numerator, and then multiplying by total prize pool, per Table 3:

Name	Numerator	Denominator $(10)^{10}$	Fraction	Prize Allocation
Player1	$4.80(10)^{10}$	$4.80+1.17+1.69+0.50=8.16$	$4.80/8.16=59\%$	$0.59(\$100)=\$59$
Player2	$1.17(10)^{10}$	$4.80+1.17+1.69+0.50=8.16$	$1.17/8.16=14\%$	$0.14(\$100)=\$14$
Player3	$1.69(10)^{10}$	$4.80+1.17+1.69+0.50=8.16$	$1.69/8.16=21\%$	$0.21(\$100)=\$21$
Player5	$0.50(10)^{10}$	$4.80+1.17+1.69+0.50=8.16$	$0.50/8.16=6\%$	$0.06(\$100)=\$6$

Table 3: Initial Pass, Prize Allocation

Inspection of Table 3 reveals that "Player2" and "Player5" would be allocated less than the threshold minimum winnings of $15. Therefore, the lower-earning player ("Player5") is eliminated and the calculation redone to distribute the $6 they would have won. This is demonstrated in Table 4 below:

Name	Numerator	Denominator $(10)^{10}$	Fraction	Prize Allocation
Player1	$4.80(10)^{10}$	$4.80+1.17+1.69=7.66$	$4.80/7.66=63\%$	$0.63(\$100)=\$63$
Player2	$1.17(10)^{10}$	$4.80+1.17+1.69=7.66$	$1.17/7.66=15\%$	$0.15(\$100)=\$15$
Player3	$1.69(10)^{10}$	$4.80+1.17+1.69=7.66$	$1.69/7.66=22\%$	$0.22(\$100)=\$22$

Table 4: Second Pass, Prize Allocation

Now, all remaining players have earnings matching or exceeding the minimum threshold, and will be compensated for their participation in the round-robin tournament accordingly.

4. Conclusion

A model was presented for compensating participants of a round-robin style tournament that can account for their performance (games won), administrative burden (admin losses), and skill level (elo). The model contains a parameter to bias for skill, and may be iterated to ensure that winnings are large compared with banking transaction fees.

Revision	Description	Change Document	Date (YYYY-MM-DD)
X1	Advanced release for community review/feedback.	N/A	2024/06/02