auto-tuning reward mechanism

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1 finality control

The leadership winning mechanism is based off Ouroborous Crypsinous with some modifications. A stakeholder wins if some random value y, specific to the stakeholder and derived from the blockchain, is less than target value T. The probability of winning is quasi linear with the relative stake.

Accuracy of single leader per slot is affected by percentage of total DRK tokens in stake, in fact the relation is logarithmic.

Assume community C owns 100% of DRK tokens.

The probability of C winning the lottery at any slot is defined as:

$$P(C = lead) = y < 1 - (1 - f)^{\alpha}$$

$$= y < 1 - (1 - f)$$

$$= y < f$$

In our case f is targetting single leader per slot. An emulation of the leader election mechanism with PID controllers shows that f is oscillating around 0.65 (depending on ration of tokens in stake). then P(C=lead) =0.35

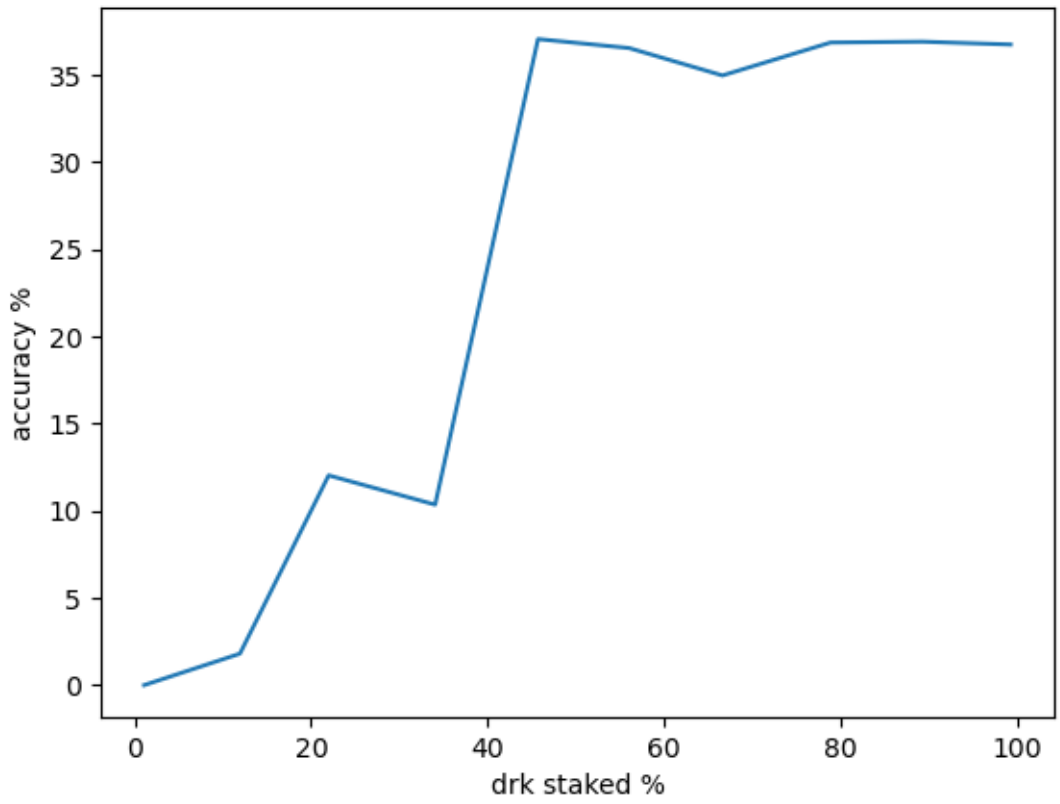
Given the linear independence property of the target function T, the probability of a node winning leadership at any slot with S staked tokens is the same as the probability of N nodes winning leadership at same slot, with same stake S for any S, N values.

If the probability of stakeholder owning 0.1% of the tokens is 0.03, then the probability of a pool consisting of stakeholders owning 0.1of tokens is also 0.03.

The probability of a pool of N% stake to win the leadership at any slot is:

$$\frac{N}{100} * P(C = lead)$$

Figure 1: relation of DRK staked vs accuracy of finality



Assume $P(C = lead) = 33\%$, then if only 10% of the total network token is staked the probability of having a single leader per slot is 0.03, or accuracy of 3%.

From the graph above, and as a consequence of the linear independence property the accuracy of the controller leaks the percentage of token in stake.

2 cascade control

to incentivize stakeholders to increase staked token, another reward controller is placed between reward and staked ratio, to incentivize staked ratio to maintain stable single lead accuracy with relatively lower staked ratio.

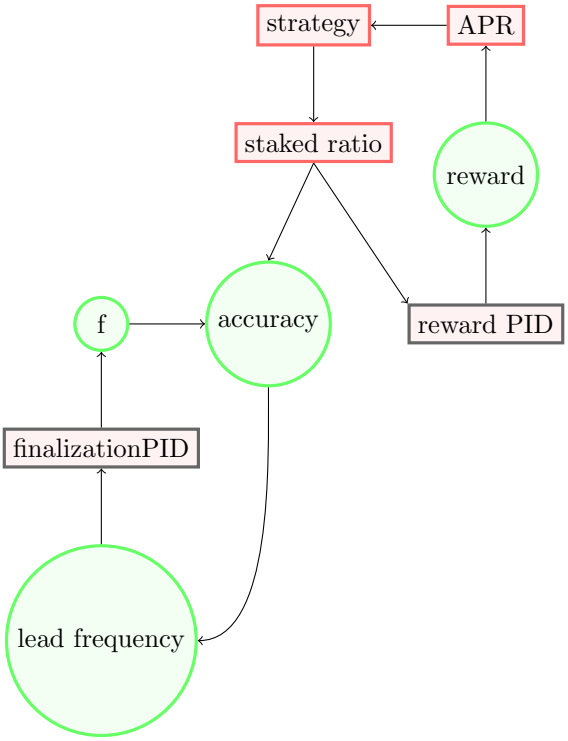


Figure 2: cascade PID diagram

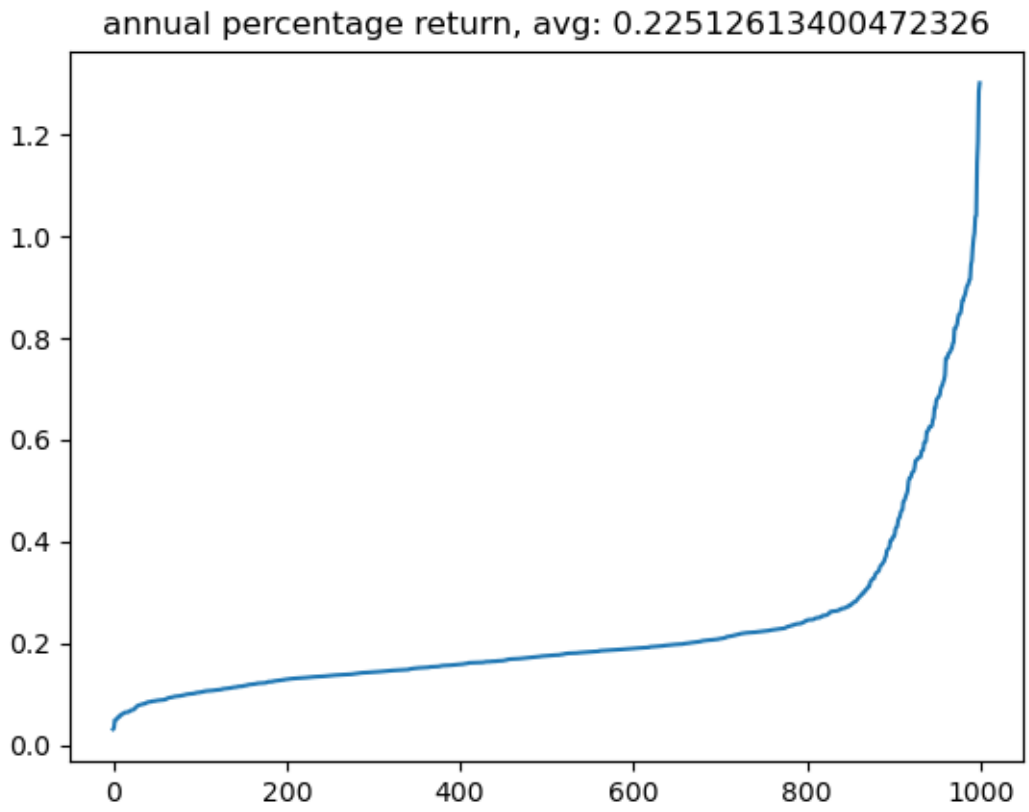


Figure 3: apr sorted from left to right in range [0-1.2]% and 0.2% on average with 100% staked ratio

the finality lead controller works at higher frequency on the slot level, outputs new f value per slot.

reward controller works at lower frequency on the epoch level, outputs new reward value per epoch, so reward is static per epoch.

3 expirments

when staked ratio is high (100% in this experiment) reward reduces to 1.33, as a consequence APR 0.2%, and staked ratio goes down on following epoch.

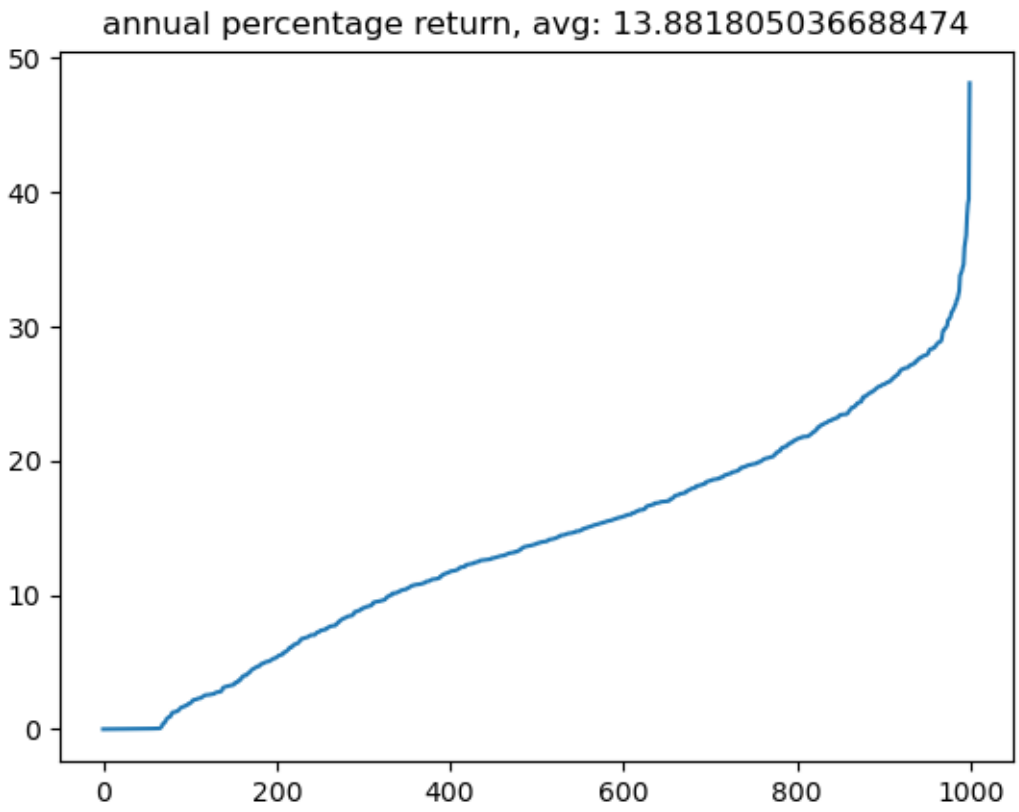


Figure 4: apr sorted from left to right in range [1-9]% and 4.2% avg apr.

while with 45% staked ratio reward goes up to 25.6 on average with 4% apr and almost same accuracy as previous experiment 34.2%