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# White Paper : Parimutuel Pools with Mutex and Long/Short Mechanisms

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## Abstract

This white paper explores the concept of parimutuel pools with two distinct mechanisms: Mutex (Mutually Exclusive) pools and Long/Short pools. The underlying codebase implements these pools, allowing users to take risk on a variety of events with different payout structures. This paper provides an overview of the mechanics, fairness, and optimization principles behind these pools.

## Introduction

Parimutuel pools are a system where all risks are pooled, and payouts are derived from the total pool after deducting a management fee. This white paper examines two types of parimutuel pools: Mutex pools and Long/Short pools. Mutex pools involve mutually exclusive events, while Long/Short pools involve scalar values (e.g., stock prices or inflation), with different payout structures depending on the outcome.

## Mutex Pools

Mutex pools are designed for situations where the outcome is a mutually exclusive event. They ensure that at least one event occurs by the expiry date, guaranteeing winners. Participants can take risk on predefined outcomes, such as "Default" or "Non-Default."

### Key Features

- **Mutually Exclusive Events**: Participants take risk on a list of distinct events.

- **Fee Structure**: Pool manager fees are deducted upfront (typically 3%).
- **Payout Calculation**: Winnings are paid from the total pool after fees, with payouts proportional to the amount bet and the odds for each event.

## Formulae for Mutex Pools

Here are the key formulae used to allocate winnings in Mutex pools:

- **Total Pool Value**: The total pool value ( TP ) is calculated by summing all bets and subtracting pool manager fees.

$$TP = \sum_{i=1}^{N} B_i - F$$

  Where ( F = TP x 3% ) represents the typical pool fees.

- **Odds Calculation**: Odds are calculated as the ratio of the total pool value to the sum of winning amounts.

$$\text{Odds} = \frac{TP}{\sum_{i=1}^{W} W_i}$$

- **Payout Calculation**: The payout for a winning bet is calculated by multiplying the bet amount by the odds.

$$P_i = B_i \times \text{Odds}$$

## Justification of Fairness

- **Transparency**: Odds and fees are clearly defined.
- **No House Advantage**: The system does not create a risk for the pool, ensuring fairness.
- **Mutually Exclusive Outcomes**: This design reduces ambiguity in determining winners.

# Long/Short Pools

Long/Short pools involve taking risk on scalar values, such as stock prices, with an emphasis on the distance between the bet and the actual outcome at expiry. This mechanism rewards accuracy and provides a unique payout structure.

## Key Features

- **Scalar Betting**: Participants take risk on whether a value will be higher or lower than a defined point at expiry.
- **Distance to the Pin**: Payouts depend on how close the bet is to the actual outcome, incentivizing accuracy.
- **Rebalancing and Reweighting**: Winning bets are reweighted based on the inverse distance to the pin.

## Formulae for Long/Short Pools

Here are the key formulae used to allocate winnings in Long/Short pools:

- **Total Pool Value**: The total pool value ( TP ) is calculated similarly to Mutex pools.

$$TP = \sum_{i=1}^{N} B_i - F$$

- **Inverse Distance to the Pin**: Represents how close a bet is to the actual outcome.

    - For Long bets:

    $$\text{Inverse Distance} = \frac{1}{\text{Closing Price} - \text{Bet Price}}$$

    - For Short bets:

    $$\text{Inverse Distance} = \frac{1}{\text{Bet Price} - \text{Closing Price}}$$

- **Normalized Inverse Distance**: The inverse distance is normalized to ensure that the sum of all normalized distances is 1.

$$\text{Normalized Inverse Distance} = \frac{\text{Inverse Distance}}{\sum \text{Inverse Distances}}$$

- **Adjusted Winning Bet Amount**: The adjusted winning bet amount is calculated by multiplying the normalized inverse distance by the total winning amount.

$$\text{Adjusted Amount} = \text{Normalized Inverse Distance} \times TP$$

- **Payout Calculation**: The payout for a winning bet in a Long/Short pool is calculated by multiplying the adjusted amount by the odds.

$$P_i = \text{Adjusted Amount} \times \text{Odds}$$

## Justification of Fairness

- **Rewarding Accuracy**: Payouts are influenced by the proximity of the bet to the actual outcome.
- **Transparent Fee Structure**: Fees are clearly defined, providing transparency.
- **Fair Payout Structure**: Reweighting based on inverse distance ensures fairness in payouts.

# Conclusion

Mutex and Long/Short pools offer a fair and transparent environment for parimutuel betting. By focusing on clear fee structures, proportional odds, and an emphasis on accuracy, these pools create a competitive environment without a house advantage, ensuring that bettors are playing against each other, not the system.

The mathematical formulae discussed ensure fairness by calculating payouts based on the total pool value, odds, and the distance to the actual outcome. These mechanisms contribute to a betting system that encourages accuracy and fairness.