

Objective Function

The key goal of a solver is to find solutions that maximize the utility of the users. However, in the objective, we also add a fee component for the service provided, and subtract costs that the transaction execution on the blockchain is expected to incur. Hence, our objective reads

$$\text{maximize } (\text{total utility}) + (\text{total fees paid}) - (\text{total execution cost}).$$

For a more formal description, we introduce an indicator variable z per (user/liquidity) order and AMM, that indicates whether the order is executed [$z(o) = 1$], or not [$z(o) = 0$]. Thus, the objective function is the following:

$$\text{maximize } \sum_{o \in O} U_o(x(o), y(o)) \cdot z(o) + \sum_{o \in O \cup L} f_o \cdot z(o) - \sum_{\alpha \in O \cup L \cup M} c_\alpha \cdot z(\alpha),$$

where the underlying variables to be determined are the indicator z -variables, the buy (x) and sell (y) amounts of each order, as well as the prices of the tokens.

Tuple below is modified to add chain I to generalize the utility function:

$$o = \langle bo, so, fo, co, To, Uo, Io, \rangle$$

where I_o is chain id.

Constraints are:

- **Trading predicate:** An order or an AMM can only be executed/used if the proposed trading amounts satisfy its *trading predicate*.
- **Uniform clearing prices:** The proposed trading amounts of all **user** orders must follow the same prices. (Batch Auctions)
- **Token conservation:** No token amounts can be created or destroyed. In other words, for every token, the total amount sold must be equal to the total amount bought of this token.
- **Economic viability of solution:** The total value of fees paid must cover the total execution cost of all the transactions, i.e.,
- **Maximum size of solution:** The total number of executed orders and AMMs cannot exceed a certain number within each batch due to limitations regarding the size of a block on the blockchain.

We also add a few more constraints:

- **One time bridging:** Each chain in the batch can only bridge once in the sequence of operations in the settlement contract. It is limiting the optimum set of solutions but is **strictly better** than the one chain COW swap. i.e. there should be strictly more COWs in the cross chain than the single chain framework.