
Algorithm 1 Modular Factor Backtest Framework

Input: Date Ranges \mathcal{T} , Stock Pools \mathcal{P} , Factor List \mathcal{F} , Config \mathcal{C} **Output:** IC/ICIR Statistics, Group Returns, Visualized PDF Reports

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1: Initialize PATHMANAGER with output directory root
2:  $Tasks \leftarrow \text{GENERATE TASK COMBINATIONS}(\mathcal{T}, \mathcal{P}, \mathcal{C}.Scenarios)$ 
3: for each  $task(t, p, s) \in Tasks$  in parallel do ▷ Parallel execution via ThreadPool
4:    $Dir \leftarrow \text{PATHMANAGER.CreateDir}(task)$ 
5:    $U \leftarrow \text{GET VALID UNIVERSE}(p, t)$  ▷ Load valid stock list
6:    $R \leftarrow \text{LOAD RETURNS}(t, \mathcal{C}.RetIdx)$  ▷ Load & slice returns
7:   for each  $name \in \mathcal{F}$  do
8:      $D_{raw} \leftarrow \text{LOAD FACTOR PARQUET}(name)$ 
9:      $D \leftarrow D_{raw} \cap U \cap t$  ▷ Filter by universe and time range
10:    if  $\mathcal{C}.IndNeu$  then
11:       $D \leftarrow \text{ZSCORE NEUTRALIZE}(D, \text{Industry})$  ▷ Industry Neutralization
12:    end if
13:     $M \leftarrow \text{MERGE}(D, R)$  ▷ Align factor with next period returns
14:     $IC, RankIC \leftarrow \text{CALC CORRELATIONS}(M)$  ▷ Calc IC & Newey-West T-stat
15:    if  $\mathcal{C}.GroupRet$  then
16:       $G_{ret}, G_{ts} \leftarrow \text{CALC GROUP RETURNS}(M, \text{bins} = 10)$ 
17:       $\text{PLOT CHARTS}(G_{ts}, Dir)$  ▷ Draw Bar & Cumulative Line charts
18:    end if
19:     $\text{SAVE TO CSV}(IC, G_{ret}, Dir)$ 
20:  end for
21:   $\text{AUTOMERGE RESULTS}(Dir)$  ▷ Merge dispersed CSV files
22:   $\text{GENERATE PDF}(Dir)$  ▷ Compile charts & stats into PDF
23: end for
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