Simulation Spec File

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1 Introduction

The simulation spec file contains the entire configuration of a simulation. It is in JSON format and divided into two main sections: "assignment," and "configuration."

The parameters in the specification file are those that can be adjusted in simulations. Below is the example `simulation_spec.json` file found in the `docs` folder:


```
{
    "assignment": {
    },
    "configuration": {
        "randomSeed": "271828",
        "numSims": "1",
        "modelName": "example",
        "presets": "NONE",
        "simLength": "60000",
        "tickSize": "1",
        "nbboLatency": "100",
        "mktLatency": "-1",
        "arrivalRate": "0.075",
        "reentryRate": "0.0005",
        "meanValue": "100000",
        "kappa": "0.05",
        "shockVar": "1E8",
        "privateValueVar": "1E8",
        "CDA": "num_2",
        "CALL": "num_0",
        "LA": "num_1",
        "BASICMM": "num_0_numRungs_10_rungSize_1000",
        "MAMM": "num_0",
        "WMAMM": "num_0",
        "ZI": "num_0_bidRangeMin_0_bidRangeMax_5000",
        "ZIR": "num_61_maxqty_10",
        "ZIP": "num_0",
        "AA": "num_0"
```

```
    }
}
```

2 Assignment

The "assignment" section is primarily for use with EGTA. It contains a nested listing of player roles with strategies assigned to players. There are currently three agent roles:

`BACKGROUND:` Background traders, who possess a private valuation for the security.

`MARKETMAKER:` Marker makers, who do not have private values.

`HFT:` High-frequency traders.

Each role used in the simulation is followed by a list of agent-strategy pairs, which take the format `<agentType>:<key>_<value1>_<key>_<value2>...`. Each agent present in the simulation is specified on its own line. For example, the section below specifies two background traders, one with range $[0, 5000]$ and one with range $[0, 1000]$, and a single market maker employing the BasicMM strategy with 100 rungs:

```
{
    "assignment": {
        "BACKGROUND": [
            "ZIR:Rmin_0_Rmax_1000",
            "ZIR:Rmin_0_Rmax_5000"
        ],
        "MARKETMAKER": [
            "BASICMM:K_100"
        ]
    }
    ...
}
```

3 Configuration

The "configuration" section specifies the parameters for the market environment as well as the agent population present. An explanation of select parameters follows (also see Table 1):

`presets:` This is a way to get easy access to "standard" market configurations. Currently there are four options:

`CENTRALCDA:` A single CDA Market.

`CENTRALCALL:` A single CALL Market that clears at the `nbboLatency`.

`TWOMARKET:` Two CDA markets and no latency arbitrageur.

`TWOMARKETLA:` Two CDA markets and a single latency arbitrageur.

`MAXEFF:` One call market, 66 background agents with max position 10.

NAME	DEFAULT	DESCRIPTION
`numSims`	1	Number of simulations to pre-aggregate; e.g., setting this parameter to 5 will generate observation files containing mean values from 5 simulation runs.
`randomSeed`	system time	Seed for the pseudorandom number generator. Random number generation is linked to the observation number, therefore a sequence of observations 0 to N will have different random numbers even when run with the same simulation spec file (and the same seed). Entering the same random seed for different models allows comparison with simulations run with common random numbers.
`modelName`	*(undefined)*	Name of market model. Only used in the output file when merging observations, as the model name will be prepended to all observation metrics in the final merged observation file.
`presets`	*(undefined)*	Examples: `CENTRALCDA`, `TWOMARKET`.
`simLength`	60000	Length of simulation in time ticks (usually interpreted as milliseconds).
`nbboLatency`	-1	Latency to update both the NBBO quote through the SIP in time steps (usually interpreted in milliseconds).
`mktLatency`	-1	Quote & transaction update latency for all markets.
`laLatency`	-1	Latency of the latency arbitrageur
`arrivalRate`	0.075	Rate for the Poisson process of agent arrival times (background traders only; market makers and HFTs arrive at time 0).
`reentryRate`	0.005	Rate of reentry for all agents. Can also be set for an agent individually, if part of its strategy.
`backgroundReentryRate`	`reentryRate`	Used by background agent if in agent constructor
`marketmakerReentryRate`	`reentryRate`	Used by market maker if in agent constructor
`tickSize`	1	Prices are integers, so the smallest tick size is 1.
`marketTickSize`	`tickSize`	
`agentTickSize`	`tickSize`	
`maxPosition`	10	Max position (long or short) for background agents.
`privateValueVar`	1E6	Variance of normally distributed i.i.d. elements of private value array; only applicable to background agents.
`meanValue`	100000	Mean for the public global fundamental value.
`kappa`	0.05	Mean-reversion parameter for the fundamental; higher kappa indicates greater degree of mean-reversion.
`shockVar`	1E6	Variance of shock to global fundamental (which is normally distributed around mean 0).

Table 1: List of environment configuration parameters.

MARKET PARAMETER	DEFAULT	DESCRIPTION
num	0	Number of a specific market configuration
quoteLatency	mktLatency	Latency of quote updates
transLatency	mktLatency	Latency of transaction updates
marketTickSize	tickSize	Tick size for a market
clearInterval	1000	Length of clearing interval of CALL market
pricingPolicy	0.5	CALL market pricing policy

Table 2: List of market configuration parameters.

Markets: The next set of options allow manually specifying market configurations if a preset is not used. Currently, there are two types of markets: CDA and CALL. The configuration string takes the format <key1>_<value1>_<key>_<value2>_..., and can contain several comma-separated configurations. The following entry would create three CALL markets. Two of these will clear every 100 ms, and one will clear every second:

```
"CALL" : "num_2_clearInterval_100,num_1_clearInterval_1000"
```

Refer to Table 2 for details on market-specific settings.

Agents: The next set of options allow manually specifying agent configurations (NOTE: LA configurations can only be set if a preset is not being used). Each agent takes a configuration string identical in style to a market, except agents will take different parameters. See Table 3 for details.

The current agents available are BASICMM, MAMM, WMAMM, ADAPTIVEMM, FUNDAMENTALMM, ZI, ZIR, ZIRP, ZIP, AA, and LA.

AGENT PARAMETER	DEFAULT	DESCRIPTION
`num`	0	Number of a specific agent configuration
`withdraw`	`true`	If true, withdraws orders upon each reentry
`window`	5000	Length of window to process, for `WindowAgents`
LA PARAMETER	DEFAULT	DESCRIPTION
`alpha`	0.001	Profit threshold of LA
`laLatency`	-1	Latency of LA
ZI PARAMETER	DEFAULT	DESCRIPTION
`Rmin`	0	Bid range minimum
`Rmax`	5000	Bid range maximum
`thresh`	0.001	Profit threshold of `ZIRP`
MM PARAMETER	DEFAULT	DESCRIPTION
`K`	100	Number of rungs on each side of the ladder
`size`	100	Rung size
`trunc`	`true`	If true, will truncate the ladder to avoid crossing current quote
`tickOutside`	`false`	If true, given ladder center prices that match the *BID* and *ASK*, will modify to be *outside* the quote by 1 tick (that is, lower than the *BID*, higher than the *ASK*)
`tickImprove`	`true`	If true, will modify ladder central if matches the current price quote (on either side)
`initLadderMean`	`meanValue`	Ladder center initialization
`initLadderRange`	1000	Ladder spread initialization
`spread`	-1	Constant spread for FundMM ladder. If this is nonpositive, MM uses the spread of the most recent price quote for the spread of its ladder.
`N`	5	Number of historical prices (quotes) to use
`w`	0	Weight factor $\in [0, 1)$ for WMAMM; if 0, linearly weighted, otherwise exponentially weighted.
`median`	`false`	If true, `AdaptiveMM` will use median spread-based strategy
`fastLearn`	`true`	If true, `AdaptiveMM` will use modification to learn more quickly (for updating G)
`lastPrice`	`true`	If true, `AdaptiveMM` will use the last price, rather than the current price, to evaluate each spread-based strategy's performance
`strats`	500, 1000, 2500, 5000	Initial spreads for strategies used by `AdaptiveMM`. Delimited in strategy string by hyphen "-"

Table 3: Incomplete list of agent configuration parameters. AAAgent and ZIPAgent parameters will eventually be converted into groups, and thus are not included here. Note that all boolean parameters can be specified by "T/t" and "F/f" in addition to "true" and "false."