Mean Reversion model:

You are given 20 daily time series (5 per asset class: Equities, FX, Commodities, Rates) going back 11 years (t-11).

1. Imagine a strategy is set up in a way that uses two signal layers to trigger a long or short.

   - First signal is triggered when the 2w, 1m and 3m *price* percentiles are above 95, 85, and 75 percentiles (short signal), or below 5, 15, and 25 percentiles (long signal).
   - Second signal is triggered when the 20d and 60d moving averages (MAs) are NOT breached.

   Only if both signals are triggered the strategy is allowed to go either long or short

   Once a mean reversion trade is set up, the system takes profit on a supportive *monthly* 30^{th} percentile move (in favor) and stops out on a counter *monthly* 20^{th} percentile move (against the position). If no moves of such magnitude happen in one month, the system stops out of the position regardless of the price after one month.

   Each trade is sized to lose the same amount of $ if stopped out.

   A) Via backtesting, determine if the given thresholds above (for both the first and second signal layer) are optimal. Describe your methodology to investigate this, execute it and illustrate your results. Start your backtest as of year t-10.

   B) Is there any difference between static or dynamic parameters over time? (I.e. is there any regime dependency, an impact of volatility clustering)? If so, how would you modify the strategy to perform better, compared to static thresholds? What would you do differently?

2. Present the backtested results of the original strategy and your modified version.

Optimal Sizing

You are supposed to create an analytical framework to determine the optimal sizing and the correct number of macro trades in a hedge fund portfolio. Suppose that the hedge fund only focuses on relative value trades in macro (Macro RV).

The overall portfolio targets an annual volatility of 15%.

Assumptions:

- Macro RV trades have a holding period of 2w to 3m and have a 50% win-rate.
- All trades are stopped out at -1.0 monthly standard deviation of returns (sigma, calculated using a *5-year lookback period and rolling monthly returns*) and take profit at +1.5 sigma. *When stopped out, each trade should lose a fixed % of AuM*.
- If none of these moves happen, Macro RV trades have a time-based stop of 3 months regardless of price action.

You are given 20 time series (the same as for the Mean Reversion model), with the information that the hedge fund manager can enter trades (long or short) in any of the assets at any given time.

You are tasked to:

1. Determine the appropriate number of trades in a year (given all other parameters are fixed: sizing based on -1 sigma stop, take profit based on +1.5 sigma, each trade loses 2% of AuM, the portfolio must generate a 15% annualized volatility)
2. Develop an algorithm that allows the user to play around with any of these variables:

- # of trades in a year
- Magnitude of the sigma stop (e.g. -1, -1.5, -2.0 etc)
- % of AuM lost at each stopped trade
- Annual volatility

  The algo should deliver updated outputs for each of the variables when one of them is modified.
  For example: if I trade 30 times a year aiming at a 15% annualized volatility, and I stop out at -1.5 sigma then what is the % of AuM I should lose each time I am stopped out?

For both the Mean Reversion and the Optimal Sizing task, you are free to choose the methodology or approach of your choice.