Arbitrage Classic Approach

Description: Find all the possible arbitrage opportunities and calculate their individual and cummulative by currency profit.

Read the data

```
tm = readtable("Quotation Matrix.xlsx", "ReadRowNames", true);
n_fx = size(tm, 1);
```

Set the currencies on which you want to sum the profits:

```
curr_buckets = {'USD', 'AUD', 'JPY', 'EUR'}
```

```
curr_buckets = 1×4 cell array
'USD'       'AUD'       'JPY'       'EUR'
```

Name the xl file on which the solutions will be saved:

```
xl_filename = 'Arbitrage normal.xlsx'
```

```
xl_filename =
'Arbitrage normal.xlsx'
```

1.Triangular Arbitrage

Specify name of the log file:

```
log_filename_roundtrip = 'log roundtrip normal.txt'
```

```
log_filename_roundtrip =
'log roundtrip normal.txt'
```

Seek and save the profitable round trip trades.

```
profits_roundtrip = {};
for i_1 = 1: n_fx
    for i_2 = 1: n_fx
        for i_3 = 1: n_fx
            base = tm.Properties.VariableNames{i_1};
            term_1 = tm.Properties.RowNames{i_2};
            term_2 = tm.Properties.RowNames{i_3};
            result = 1 * tm{term_1, base} * ...
                tm{term_2, term_1} * tm{base, term_2};
            if result > 1
                profits_roundtrip{end+1, 1} = {base, term_1, term_2};
                profits_roundtrip{end, 2} = result - 1;
            end
        end
    end
end
```

Group identical opportunities:

Identify the unique arbitrage opportunities and group the ones that are identical.

Each cell array row of profits_grouped is of the following format:

{{curr_1, curr_2, curr_3}, profit, {cell array which elements are the profits rows as defined in the previous section}}

```
profits_group_by = utils('profits_group_by');
profits_grouped_roundtrip = profits_group_by(profits_roundtrip)
```

```
profits_grouped_roundtrip = 11×3 cell
```

	1	2	3
1	1×3 cell	0.0012	1×3 cell
2	1×3 cell	2.9101e-04	1×3 cell
3	1×3 cell	0.0012	1×3 cell
4	1×3 cell	0.0023	1×3 cell
5	1×3 cell	2.1304e-04	1×3 cell
6	1×3 cell	1.2264e-04	1×3 cell
7	1×3 cell	0.0023	1×3 cell
8	1×3 cell	3.3525e-04	1×3 cell
9	1×3 cell	0.0048	1×3 cell
10	1×3 cell	0.0039	1×3 cell
11	1×3 cell	0.0048	1×3 cell

Display the arbitrage opportunities and their respective trades:

The quotes in the printed (and logged) message refer to the the bid quotes.

```
pretty_print_grouped_profits = utils('pretty_print_grouped_profits');
output_roundtrip = evalc('pretty_print_grouped_profits(profits_grouped_roundtrip, tm)')
```

```
output_roundtrip =
    '1. Triangle: USD-->AUD-->JPY-->USD
         1.1 profit=1USD*1.244AUD/USD*86.8523JPY/AUD*0.0092666USD/JPY=0.0012077USD
         1.2 profit=1JPY*0.0092666USD/JPY*1.244AUD/USD*86.8523JPY/AUD=0.0012077JPY
         1.3 profit=1AUD*86.8523JPY/AUD*0.0092666USD/JPY*1.244AUD/USD=0.0012077AUD
     2. Triangle: USD-->CAD-->JPY-->USD
         2.1 profit=1USD*1.0693CAD/USD*100.9495JPY/CAD*0.0092666USD/JPY=0.00029101USD
         2.2 profit=1JPY*0.0092666USD/JPY*1.0693CAD/USD*100.9495JPY/CAD=0.00029101JPY
         2.3 profit=1CAD*100.9495JPY/CAD*0.0092666USD/JPY*1.0693CAD/USD=0.00029101CAD
     3. Triangle: USD-->CHF-->JPY-->USD
         3.1 profit=1USD*1.1352CHF/USD*95.1715JPY/CHF*0.0092666USD/JPY=0.0011558USD
         3.2 profit=1JPY*0.0092666USD/JPY*1.1352CHF/USD*95.1715JPY/CHF=0.0011558JPY
         3.3 profit=1CHF*95.1715JPY/CHF*0.0092666USD/JPY*1.1352CHF/USD=0.0011558CHF
     4. Triangle: USD-->JPY-->GBP-->USD
         4.1 profit=1USD*107.86JPY/USD*0.0053GBP/JPY*1.7533USD/GBP=0.0022829USD
         4.2 profit=1JPY*0.0053GBP/JPY*1.7533USD/GBP*107.86JPY/USD=0.0022829JPY
         4.3 profit=1GBP*1.7533USD/GBP*107.86JPY/USD*0.0053GBP/JPY=0.0022829GBP
     5. Triangle: EUR-->AUD-->JPY-->EUR
         5.1 profit=1EUR*1.7441AUD/EUR*86.8523JPY/AUD*0.006603EUR/JPY=0.00021304EUR
         5.2 profit=1JPY*0.006603EUR/JPY*1.7441AUD/EUR*86.8523JPY/AUD=0.00021304JPY
```

```
        5.3 profit=1AUD*86.8523JPY/AUD*0.006603EUR/JPY*1.7441AUD/EUR=0.00021304AUD
    6. Triangle: EUR-->CHF-->JPY-->EUR
        6.1 profit=1EUR*1.5915CHF/EUR*95.1715JPY/CHF*0.006603EUR/JPY=0.00012264EUR
        6.2 profit=1JPY*0.006603EUR/JPY*1.5915CHF/EUR*95.1715JPY/CHF=0.00012264JPY
        6.3 profit=1CHF*95.1715JPY/CHF*0.006603EUR/JPY*1.5915CHF/EUR=0.00012264CHF
    7. Triangle: EUR-->JPY-->GBP-->EUR
        7.1 profit=1EUR*151.22JPY/EUR*0.0053GBP/JPY*1.2506EUR/GBP=0.0022845EUR
        7.2 profit=1JPY*0.0053GBP/JPY*1.2506EUR/GBP*151.22JPY/EUR=0.0022845JPY
        7.3 profit=1GBP*1.2506EUR/GBP*151.22JPY/EUR*0.0053GBP/JPY=0.0022845GBP
    8. Triangle: JPY-->CAD-->AUD-->JPY
        8.1 profit=1JPY*0.0099CAD/JPY*1.1634AUD/CAD*86.8523JPY/AUD=0.00033525JPY
        8.2 profit=1CAD*1.1634AUD/CAD*86.8523JPY/AUD*0.0099CAD/JPY=0.00033525CAD
        8.3 profit=1AUD*86.8523JPY/AUD*0.0099CAD/JPY*1.1634AUD/CAD=0.00033525AUD
    9. Triangle: JPY-->GBP-->AUD-->JPY
        9.1 profit=1JPY*0.0053GBP/JPY*2.1829AUD/GBP*86.8523JPY/AUD=0.0048264JPY
        9.2 profit=1GBP*2.1829AUD/GBP*86.8523JPY/AUD*0.0053GBP/JPY=0.0048264GBP
        9.3 profit=1AUD*86.8523JPY/AUD*0.0053GBP/JPY*2.1829AUD/GBP=0.0048264AUD
    10. Triangle: JPY-->GBP-->CAD-->JPY
        10.1 profit=1JPY*0.0053GBP/JPY*1.8763CAD/GBP*100.9495JPY/CAD=0.0038815JPY
        10.2 profit=1GBP*1.8763CAD/GBP*100.9495JPY/CAD*0.0053GBP/JPY=0.0038815GBP
        10.3 profit=1CAD*100.9495JPY/CAD*0.0053GBP/JPY*1.8763CAD/GBP=0.0038815CAD
    11. Triangle: JPY-->GBP-->CHF-->JPY
        11.1 profit=1JPY*0.0053GBP/JPY*1.992CHF/GBP*95.1715JPY/CHF=0.0047824JPY
        11.2 profit=1GBP*1.992CHF/GBP*95.1715JPY/CHF*0.0053GBP/JPY=0.0047824GBP
        11.3 profit=1CHF*95.1715JPY/CHF*0.0053GBP/JPY*1.992CHF/GBP=0.0047824CHF
    '
```

```
% Write output
log_file = fopen(log_filename_roundtrip, 'w+');
fwrite(log_file, output_roundtrip);
fclose(log_file);
```

Calculate the cumulative profits:

```
profits_grouped2curr_buckets = utils('profits_grouped2curr_buckets');

buckets_roundtrip = profits_grouped2curr_buckets(profits_grouped_roundtrip, curr_bucket
```

```
buckets_roundtrip = struct with fields:
    USD: 0.0049
    AUD: 0.0054
    JPY: 0.0111
```

Save the outputs to excel file.

First we create a sheet on which we save the environment data. That is the quotation matrix.

Then we save the arbitrage opportunities with their respective profits.

Finally we save the cumulative profits.

```
writetable(tm, xl_filename, 'Sheet', 'Input Quotes', "WriteRowNames", true);
write_profits(profits_grouped_roundtrip, xl_filename, 'Triangular arbitrage');
writetable(struct2table(buckets_roundtrip), xl_filename, 'Sheet', 'Triangular Cum Profi
```

2.One-Way-Arbitrage

Specify name of the logging file:

```
log_filename_oneway = 'log oneway normal.txt'
```

```
log_filename_oneway = 
'log oneway normal.txt'
```

Define starting and ending currencies.

```
curr_start = 'EUR';
curr_end = 'JPY';
```

Seek and save the profitable round trip trades.

```
profits_oneway = {};
for i = 1:n_fx
    term = tm.Properties.VariableNames{i};
    result = tm{term, curr_start}*tm{curr_end, term} - tm{curr_end, curr_start};
    if result > 0
        profits_oneway{end+1, 1} = {curr_start, tm.Properties.VariableNames{i}};
        profits_oneway{end, 2} = result;
    end
end
```

Display the arbitrage opportunities and their respective trades:

The quotes in the printed (and logged) message refer to the the bid quotes.

```
pretty_print_profits_oneway = utils('pretty_print_profits_oneway');
output_oneway = evalc('pretty_print_profits_oneway(profits_oneway, curr_end, tm)')
```

```
output_oneway = 
    '1. Triangle: EUR-->CHF-->JPY
         profit=1EUR*1.5915CHF/EUR*95.1715JPY/CHF-151.22JPY/EUR=0.2454JPY
     2. Triangle: EUR-->CAD-->JPY
         profit=1EUR*1.4992CAD/EUR*100.9495JPY/CAD-151.22JPY/EUR=0.12354JPY
     3. Triangle: EUR-->AUD-->JPY
         profit=1EUR*1.7441AUD/EUR*86.8523JPY/AUD-151.22JPY/EUR=0.25909JPY
     '
```

```
% Write output
log_file = fopen(log_filename_oneway, 'w+');
fwrite(log_file, output_oneway);
fclose(log_file);
```

Calculate the cumulative profits:

```
buckets_oneway.(curr_end) = sum([profits_oneway{:, 2}])
```

```
buckets_oneway = struct with fields:
    JPY: 0.6280
```

Save the outputs to excel file.

We save the arbitrage opportunities with their respective profits and then we save the cumulative profits.

```
write_profits(profits_oneway, xl_filename, 'OneWay Arbitrage');
```

```
writetable(struct2table(buckets_oneway), xl_filename, 'Sheet', 'OneWay Cum Profits');
```