



UBS Investment Research

Building flexibility into R code: A case study using backtesting code

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Setting the scene

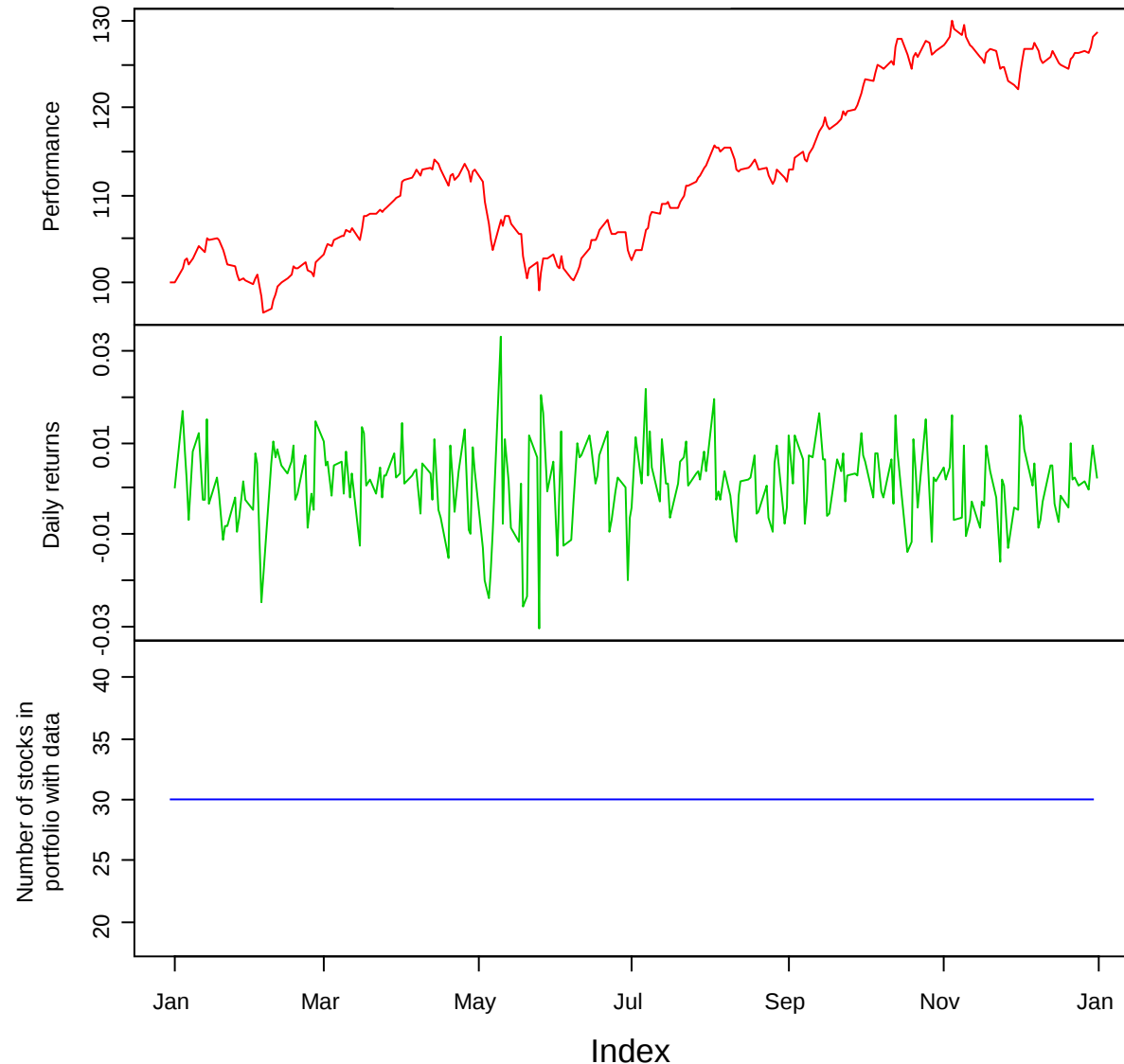
The problem

- Generate simulated performances for a portfolio of stocks chosen by any well defined set of quantitative rules.

E.g. top 50 stocks with the highest dividend yield or a minimum variance portfolio or all stocks that meet the criteria of a screen.

Is flexibility a good thing here?

- **Yes** - there is enough overlap between what is required to generate different backtests, and the analysis of the results after the backtest that a single set of code is useful.



This document is for illustrative purposes only

Why use R at all for this project?

Why use R for this at all?

- **Makes use of pre-existing work by the R community:** R packages have huge quantities of useful functions to analyse returns time series and produce charts e.g. performanceAnalytics.
- **Easy connection to the database:** RODBC makes connecting to SQL database (essential given the size of the data we need to use) straightforward.
- **Easy to move results to and from excel:** Most clients want excel files as an output, R makes it easy to do this
- **Historical reasons:** Most of the code we use to produce quantitative investment signals was already written in R.
- **Charting capacity:** The graphics of R are so customisable and easy to manipulate.

Break up the backtesting process into sub-process

backtestFunction

Fetch static data

Loop over each date

Define universe

Fetch signal data

Create quantitative investment signal

Choose stocks and their weights based on this signal i.e. create the portfolio

Fetch returns data

Compute returns to portfolios

End loop

Charting

Statistics

Return results

Classify each process

Rumsfeld Class

Description

Example

Knowns

Processes that are the same (down to a few variables) from backtest to backtest, i.e. could use one set of code

Fetching returns data

Known unknowns

Families of processes that serve the same general purpose, but are substantially different from backtest to backtest so will require different code.

Choosing weights for stocks in a portfolio

Unknown unknowns

Adding new sub-processes

Calculating returns after transaction costs

Knowns

- **Example:** Fetching returns data
- Small enough choice of possibilities that it can be comfortably dealt with using if statements (my rule is max 3)
- Fetching returns data process has three possible cases
 - data coming from an access table,
 - from a SQL table
 - or from a matrix saved in the R workspace
- **Solution:** Code once, usually easiest to write a function to be used internally by the main code “backtestFunction”
- **Tests:** the extreme cases, this code needs to be extremely robust and have sensible warning messages
 - What if I ask for data not available in the database?
 - What if I ask for no data?
 - What if I ask for > 10,000 stocks’ return data?

Known Unknowns (1)

- **Example:** Choosing weights for stocks in a portfolio
- This process is too different from case to case to use a single set of code
 - Equal weighting
 - Weighting proportional to the signal created earlier in the code
 - Risk neutral weighting etc.
- Each of these requires very different calculations, and will need different variables as inputs.

Known Unknowns (2)

Solution: Create a family of functions, one for each way of choosing weights and make the chooseWeightsFunction an input to the backtestFunction.

Then use the ellipsis to feed any additional variables down to the function.

> args(backtestFunction)

tradeFreq, from, to, tradeDatesList,
retName, retCon,
region, industryFund, sectorType,
countryType,

} **Inputs to known processes**

createSignalFunction,
riskModelFunction,
chooseStocksFunction,
chooseWeightsFunction,

} **Known unknown processes**

portStatsFunction,
...

All inputs to the known unknown processes are passed through the ellipsis.

This has the added advantage of reducing the number of arguments to backtestFunction

Known Unknowns (3)

Sensible defaults

Users always want simplicity, but also demand to be able to alter every parameter - sensible defaults are the best compromise.

Save the inputs to the backtest function

Combine *args* and *match.call* functions to get both the default inputs and the specified inputs (to avoid version control problems).

This makes the output to the function easily understandable and completely replicable. This saved endless heartache.

Unknown unknowns

- **Example:** Computing returns after transaction costs
- This is an entirely new type of sub-process.
- It needs to use data that is not computed or stored in the existing backtestFunction (what proportion of the portfolio changes when we rebalance) so it cannot be integrated with the existing code.
- This is an example of mission creep and is very hard to plan for.

What I wish I had known before I started ...

General project control:

- People are capricious: put proper version control in place before you get started
- People don't think about processes but are good at remembering examples. Planning this project got much easier after I asked my team to tell me all the different types of backtesting they had used in the last year.
- People react much, much better to a documented example than to an explanation of what the code can do. Start from the output and wait until they describe what is missing or demand to know how to do it themselves.

More specific to R

- Give up on specifying all the parameters of the function and embrace the ellipsis. Knowing every parameter might look like the simpler approach but four pages of parameters and their definitions is the inevitable outcome.
- It is worth reading the documentation of functions even if you already use them daily e.g. discovering the "recursive" argument in *unlist* greatly simplified a problem and using "drop=TRUE" for factor levels.
- There is nothing wrong with sticking with the most basic classes e.g. matrices rather than xts objects, and it makes your code simpler.

Conclusions

The management question, therefore, is not whether to build a pilot system and throw it away. You will do that. [...] Hence plan to throw one away; you will, anyhow.

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We made it in four.

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