MONTE CARLO SIMULATION FOR SENSITIVITY ANALYSIS OF RISKS

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ABOUT US

We are AssetHandling Ltd, based at Sci-Tech Daresbury.

Two main products – Asset Insight Manager and Programme Insight Manager

www.assethandling.com
Monte Carlo simulation is mathematical technique that produces distributions of possible outcome values.

One main application is “to account for risks in quantitative analysis and decision making”.
Sensitivity analysis (also known as what-if analysis) is used to determine the value of an individual risk change by varying an independent input.

Works using a combination of PERT analysis and Monte Carlo simulation

- Program (or project) evaluation and review technique, commonly abbreviated PERT is a statistical tool, used in project management. It is useful for modelling expert data.
- Other methods to model the distribution to generate sample values include uniform distribution, triangular distribution.
PROCESS OVERVIEW

[Diagram showing project risk analysis with distribution functions and sensitivity analysis at project and programme levels.]
Libraries used `data.table` and `mc2d`

`data.table` is an R package that provides an enhanced version of `data.frames`. `mc2d` means Two-Dimensional Monte-Carlo. Package provides additional probability distributions and other tools to construct and analysis One-Dimensional and Two-Dimensional simulations.
DISCUSSION ON R CODE

```r
# generate PERT series from mc2d library for each risk
dt_sim <- dt_in[, list(mcr_PERT_cost = list(round(rpert(1001, c_min_cost, c_ml_cost, c_max_cost, shape = 6),2)),
mcr_PERT_time = list(round(rpert(1001, c_min_time, c_ml_time, c_max_time, shape = 6),2)),
by = c("node_id",
    "programme_id",
    "pestle_id")[, list(mcr_PERT_cost = as.numeric(unlist(mcr_PERT_cost))
mcr_PERT_time = as.numeric(unlist(mcr_PERT_time))
by = c("node_id", "programme_id", "pestle_id")
)mcr_cum_cost = round(fran)
mcr_cum_time = round(fran)
mcr_PERT_time = round(fran)
```

DISCUSSION ON R CODE

```r
## Evaluate the series generated for calculate a score for each identified risk

dt_res1 <- dt_sim[,]

res = lapply(cols, function(i) {
    vars = paste(c('mcr_PERT', 'mcr_cum', 'c_min', 'c_ml', 'c_max'), i, sep = ' - ')
    
    min = get(vars[1])[(which.min(abs(get(vars[1]) - get(vars[3]))))]
    ml = get(vars[1])[(which.min(abs(get(vars[1]) - get(vars[4]))))]
    max = get(vars[1])[(which.min(abs(get(vars[1]) - get(vars[5]))))]
    round((min + (4 * ml) + max) / 6, 2)
})

names(res) = paste('mcr_score', cols, sep = " - ")
res

},
by = c("programme_id", "node_id", "pestle_id")
```
DISCUSSION ON R CODE

```r
# using the generated PERT series calculate the total possible "risk" from the identified risks

dt_dist1 <-
  rbinder(replicate(1001, dt_siml[, list(
    mcr_PERT_cost = sample(mcr_PERT_cost, size = 1),
    mcr_PERT_time = sample(mcr_PERT_time, size = 1)
  ), by = c("node_id", "pestle_id"))[, list(
    mcr_PERT_cost = sum(mcr_PERT_cost, na.rm = TRUE),
    mcr_PERT_time = sum(mcr_PERT_time, na.rm = TRUE)
  ), by = c("node_id")), simplify = FALSE)[, `:=`
    mcr_cum_cost = round(frank(mcr_PERT_cost, ties.method = "max") / sum(!is.na(mcr_PERT_cost), 2),
    mcr_cum_time = round(frank(mcr_PERT_time, ties.method = "max") / sum(!is.na(mcr_PERT_time), 2)
    ), by = c("node_id"))
```
THANK YOU FOR LISTENING

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