SOCIETY OF ACTUARIES

2022 ASIA-PACIFIC SYMPOSIUM

Developing Actuarial Applications Using R Shiny

June 2022

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SOA Antitrust Compliance Guidelines

Active participation in the Society of Actuaries is an important aspect of membership. While the positive contributions of professional societies and associations are well-recognized and encouraged, association activities are vulnerable to close antitrust scrutiny. By their very nature, associations bring together industry competitors and other market participants.
The United States antitrust laws aim to protect consumers by preserving the free economy and prohibiting anti-competitive business practices; they promote competition. There are both state and federal antitrust laws, although state antitrust laws closely follow federal law. The Sherman Act, is the primary U.S. antitrust law pertaining to association activities. The Sherman Act prohibits every contract, combination or conspiracy that places an unreasonable restraint on trade. There are, however, some activities that are illegal under all circumstances, such as price fixing, market allocation and collusive bidding.

There is no safe harbor under the antitrust law for professional association activities. Therefore, association meeting participants should refrain from discussing any activity that could potentially be construed as having an anti-competitive effect. Discussions relating to product or service pricing, market allocations, membership restrictions, product standardization or other conditions on trade could arguably be perceived as a restraint on trade and may expose the SOA and its members to antitrust enforcement procedures.

While participating in all SOA in person meetings, webinars, teleconferences or side discussions, you should avoid discussing competitively sensitive information with competitors and follow these guidelines:

- Do not discuss prices for services or products or anything else that might affect prices
- Do not discuss what you or other entities plan to do in a particular geographic or product markets or with particular customers.
- Do not speak on behalf of the SOA or any of its committees unless specifically authorized to do so.
- Do leave a meeting where any anticompetitive pricing or market allocation discussion occurs.
- Do alert SOA staff and/or legal counsel to any concerning discussions
- Do consult with legal counsel before raising any matter or making a statement that may involve competitively sensitive information.

Adherence to these guidelines involves not only avoidance of antitrust violations, but avoidance of behavior which might be so construed. These guidelines only provide an overview of prohibited activities. SOA legal counsel reviews meeting agenda and materials as deemed appropriate and any discussion that departs from the formal agenda should be scrutinized carefully. Antitrust compliance is everyone's responsibility; however, please seek legal counsel if you have any questions or concerns.

Presentation Disclaimer

Presentations are intended for educational purposes only and do not replace independent professional judgment. Statements of fact and opinions expressed are those of the participants individually and, unless expressly stated to the contrary, are not the opinion or position of the Society of Actuaries, its cosponsors or its committees. The Society of Actuaries does not endorse or approve, and assumes no responsibility for, the content, accuracy or completeness of the information presented. Attendees should note that the sessions are audio-recorded and may be published in various media, including print, audio and video formats without further notice.

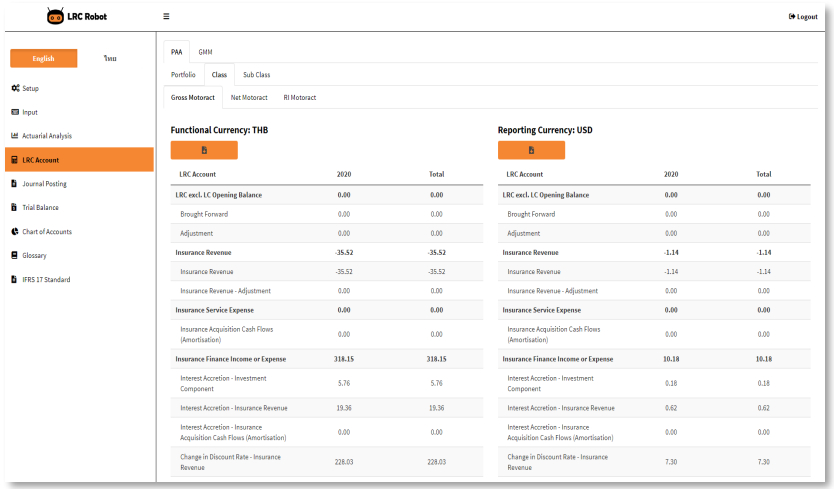
Content

Content

How R Shiny Works?

Server Instructions

User Interface (UI)



Content

```
library(shiny)

ui <- dashboardPage()

server <- function(input, output) {}

shinyApp(ui = ui, server = server)
```

R Shiny Package

Visual Elements

Logic Defined

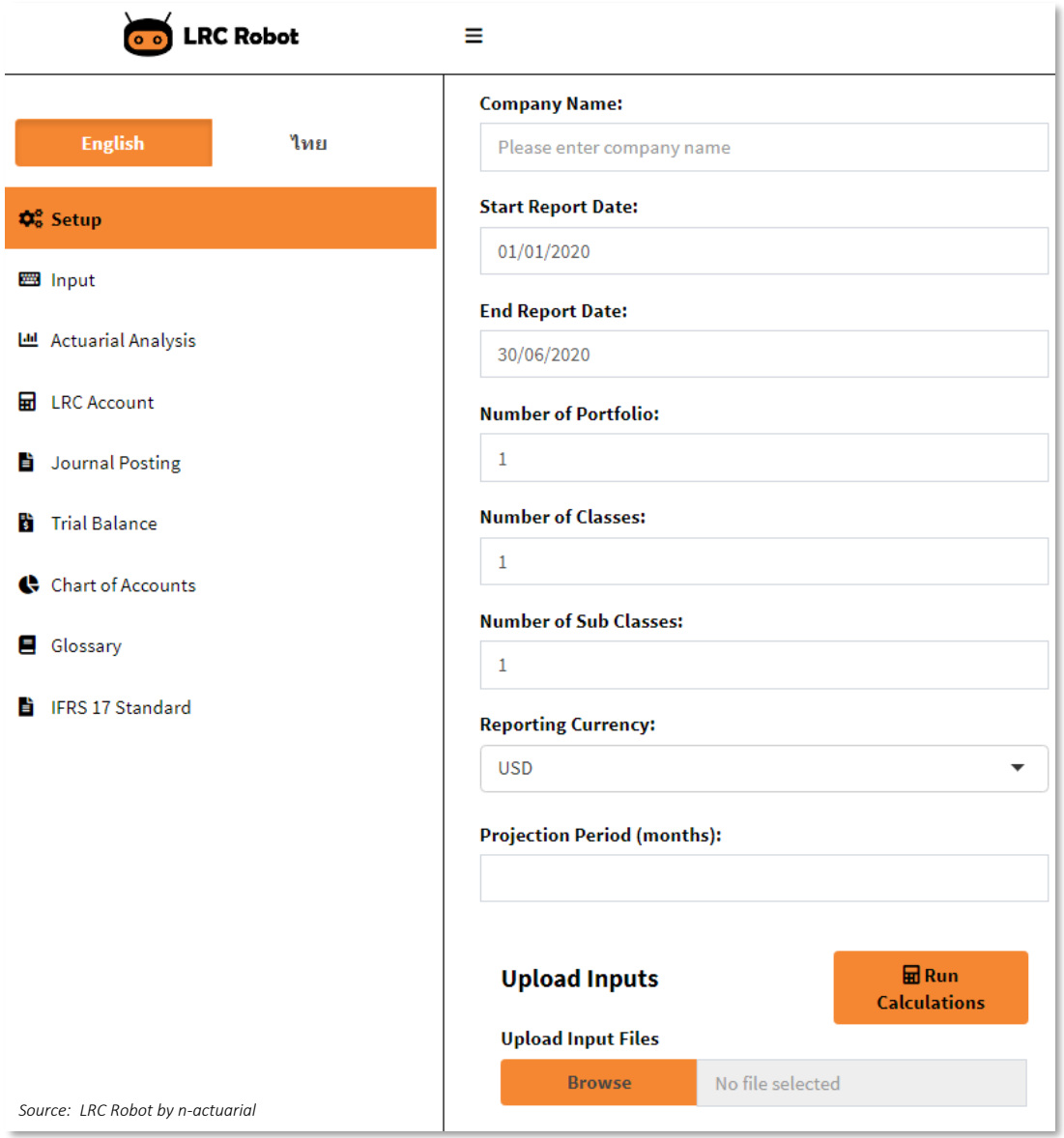
Deploy App

```
ui <-
  dashboardPage(
    title = "LRC Robot",
    dashboardHeader(title = tags$a(
      tags$img(src = "LRC.robot/LRC logo.png",
      style = margin: auto;")),
      href = "https://www.n-actuarial.com/",
      titleWidth = 320),

      dashboardSidebar(uiOutput("languagebtn"),
      uiOutput("sidebar"), width = 320),

      dashboardBody(
        useShinyjs(),
        uiOutput("body"))
    )
  )
```

Header

Sidebar

Body



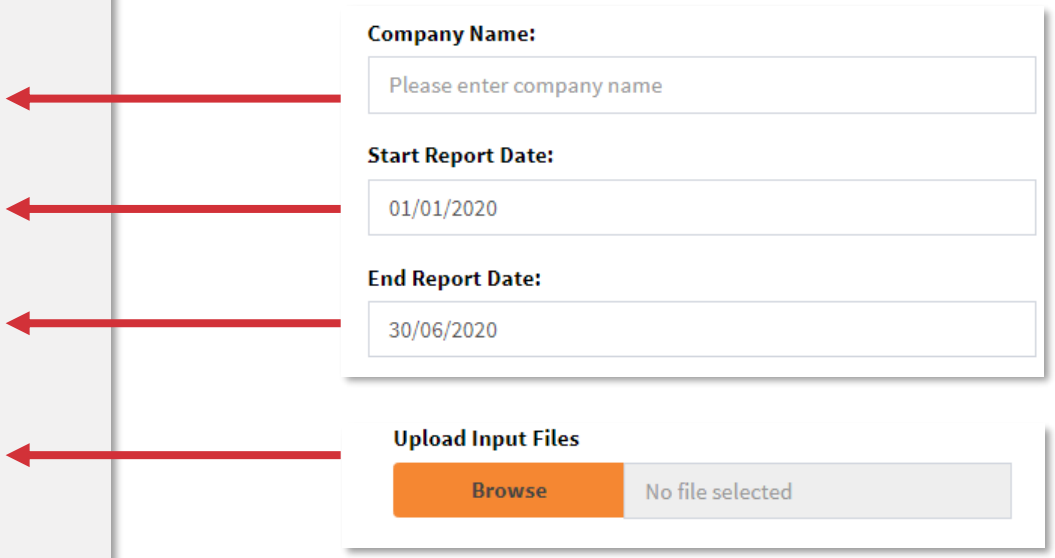
Source: LRC Robot by n-actuarial

```
server <- function(input, output) {
 output$body <- renderUI({
          tabItems(
          ui_setup("setup", "Setup"),
          ui_input("input", "Input"),
          .
          .
          .
 })

 ui_setup <- function(id, tabName) {
          tabItem(tabName = tabName,
          fluidRow(
           column(4,
          textInput('com_name', "Company Name: ",
          placeholder = "Please enter company name"),
          dateInput('start_date', "Start Report Date: ",
          value = '2020/01/01',
          format = "dd/mm/yyyy"),
          dateInput('end_date', "End Report Date: ",
          value = '2020/06/30',
          format = "dd/mm/yyyy"),
          fileInput("input_data", 'Upload Input Files',
          accept = c('text/csv', 'text/plain','.csv'),
          buttonLabel = "Browse")
          ))
          )
 }
}
```

Text input

Date input

File input



```
result_table <- reactive({
          data = input$input_data,
          coa = data.table()
          coa[, "Account Code" := ...,
              "Account Type" := ...,
              "Financial Statement" := ...,
              .
              .
              .
              "Opening" := ...,
              "Movement" := ...,
              "Closing" := ...]
          .
          .
          .
          return(coa)
})

output$result_dt <-renderDataTable({
          datatable(result_table())
})

output$result_download <- downloadHandler({
          filename = c('Chart of
                        Accounts.csv'
          content = function(file) {
          write.csv(result_table(), file)}
})
```

Reactive function

Render function

Download handler

```
output$body <- renderUI({
          box(
          downloadButton("result_download"),
          dataTableOutput("result_dt")
          )
})
```

Output function

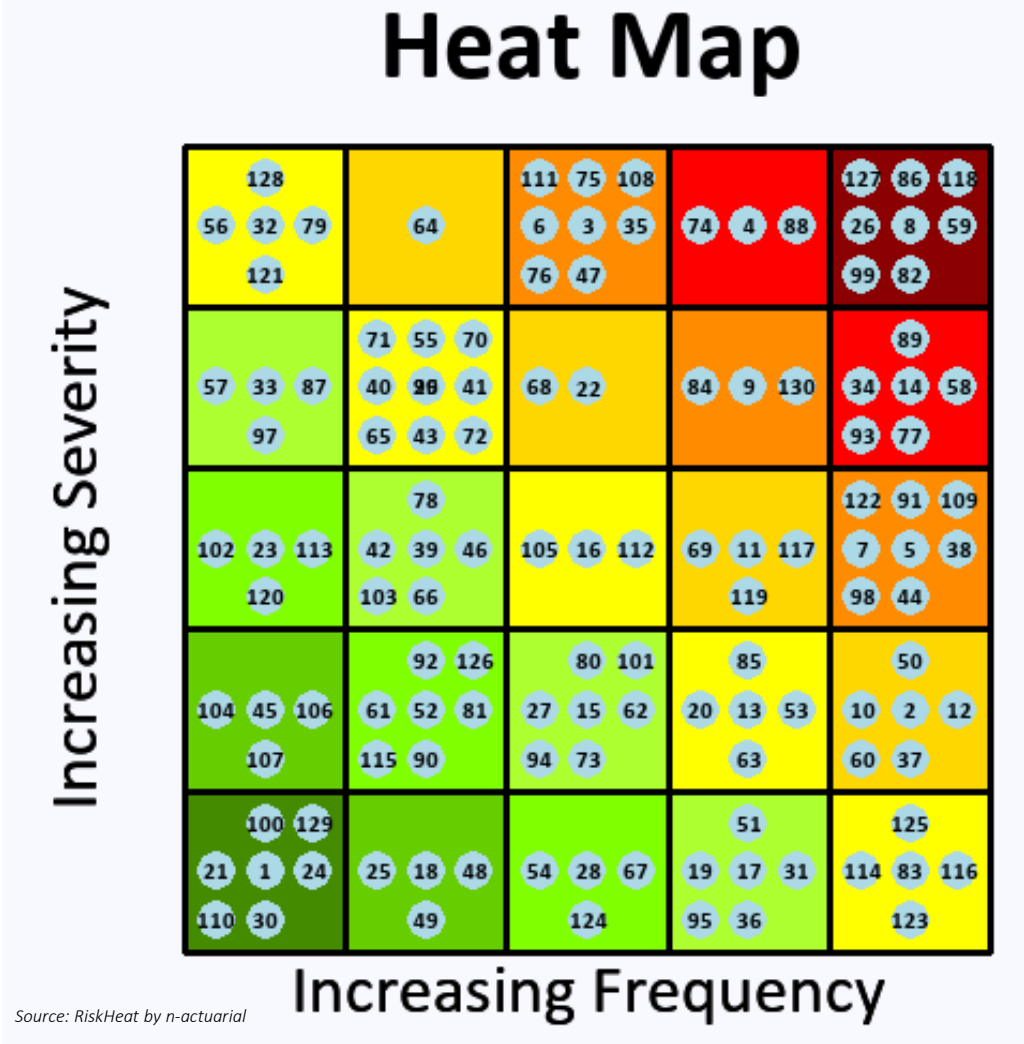
Source: LRC Robot by n-actuarial

Show 10 entries

Search:

Account Code	Account Type	Financial Statement	Description 1	Description 2	Description 3	Description 4	Description 5	Functional Currency (THB)			Reporting Currency (USD)		
								Opening	Movement	Closing	Opening	Movement	Closing
10201	Asset	Balance Sheet	Bank	Cash Flows	Premiums Received	-	-	0.00	250.00	250.00	0.00	8.00	8.00
20104	Liability	Balance Sheet	PAA LRC excl. LC	Cash Flows	Premiums Received	-	-	0.00	-250.00	-250.00	0.00	-8.00	-8.00
40100	Revenue	Income Statement	Profit or Loss	Insurance Revenue	-	-	-	0.00	-35.52	-35.52	0.00	-1.14	-1.14
20105	Liability	Balance Sheet	PAA LRC excl. LC	Insurance Revenue	-	-	-	0.00	35.52	35.52	0.00	1.14	1.14
40101	Revenue	Income Statement	Profit or Loss	Insurance Revenue	Adjustment	-	-	0.00	0.00	0.00	0.00	0.00	0.00
20106	Liability	Balance Sheet	PAA LRC excl. LC	Insurance Revenue	Adjustment	-	-	0.00	0.00	0.00	0.00	0.00	0.00
30103	Expenses	Income Statement	Profit or Loss	Insurance Finance Income or Expenses	Interest Accretion	Insurance Revenue	-	0.00	19.36	19.36	0.00	0.62	0.62
20107	Liability	Balance Sheet	PAA LRC excl. LC	Insurance Finance Income or Expenses	Interest Accretion	Insurance Revenue	-	0.00	-19.36	-19.36	0.00	-0.62	-0.62

```
plotting = reactive({
          plot(c(0, 5), c(0, 5), type = "n", asp=1,
          main="Heat Map",    xlim=c(0,5), ylim=c(0,5),
          ylab="", xlab="", axes = FALSE, cex.main = 3)
          mtext(text = "Increasing Severity", side = 2,
          line = 0, cex = 2)
          mtext(text = "Increasing Frequency", side = 1,
          line = 0, cex = 2)
for ( i in 0:4 ) {
for ( j in 0:4 ) {
          rect( 0+i, 0+j, 1+i, 1+j, border = TRUE,
          col = ifelse(i+j == 0, "chartreuse4" ,
          ifelse(i+j == 1, "chartreuse3",
          ifelse(i+j == 2, "chartreuse",
          ifelse(i+j == 3, "greenyellow" ,
          ifelse(i+j == 4, "yellow",
          ifelse(i+j == 5, "gold",
          ifelse(i+j == 6, "darkorange",
          ifelse(i+j == 7, "red", "darkred"))))))))}}
          .
          .
          .
})

output$myplot = renderPlot({
          withProgress(message = "Generating plot ...",
          value = 0.1, style = "notification", {
          plotting()
})}, bg = "ghostwhite", height = 500, width = 500)
```



Source: RiskHeat by n-actuarial

```
manual_adjustment = fread('manual adjustment.csv')

lrc_report = function(..., manual_adjustment){
          .
          .
          manual_adj = manual_adjustment
          .
          .
          set(account_lrc, i=1L, j=j,
          value = results[DataType == ...] +
                  manual_adj[DataType == ...])
          .
          .
          .
```

Source: LRC Robot by n-actuarial

LRC Account	2020
LRC excl. LC Opening Balance	**0.00**
Brought Forward	0.00
Adjustment	0.00
Insurance Revenue	**-35.52**
Insurance Revenue	-35.52
Insurance Revenue - Adjustment	0.00
Insurance Service Expense	**0.00**
Insurance Acquisition Cash Flows (Amortisation)	0.00
Insurance Finance Income or Expense	**318.15**
Interest Accretion - Investment Component	5.76
Interest Accretion - Insurance Revenue	19.36
Interest Accretion - Insurance Acquisition Cash Flows (Amortisation)	0.00
Change in Discount Rate - Insurance Revenue	228.03
Change in Discount Rate - Investment Component	64.99
Change in Discount Rate - Insurance Acquisition Cash Flows (Amortisation)	0.00
Transfer to LIC	**-0.00**
Transfer to LIC - Investment Component	-0.00

Before manual adjustment

LRC Account	2020
LRC excl. LC Opening Balance	**58.00**
Brought Forward	0.00
Adjustment	58.00
Insurance Revenue	**-23.52**
Insurance Revenue	-35.52
Insurance Revenue - Adjustment	12.00
Insurance Service Expense	**0.00**
Insurance Acquisition Cash Flows (Amortisation)	0.00
Insurance Finance Income or Expense	**318.15**
Interest Accretion - Investment Component	5.76
Interest Accretion - Insurance Revenue	19.36
Interest Accretion - Insurance Acquisition Cash Flows (Amortisation)	0.00
Change in Discount Rate - Insurance Revenue	228.03
Change in Discount Rate - Investment Component	64.99
Change in Discount Rate - Insurance Acquisition Cash Flows (Amortisation)	0.00
Transfer to LIC	**21.00**
Transfer to LIC - Investment Component	21.00

After manual adjustment

```
cession = function(input_policy,...){
          .
          .
          tbl = data.table(input_policy)
          .
          .
          tbl[, 'Aggregation':=
              cumsum(!duplicated(`PolicyNumber`)),
              by = 'CustomerID']
          .
          .
}
```

Source: ReACC by n-actuarial

Customer ID	Tranche	Policy Number	Aggregation	Entry Age	Gender	Policy Start Date
1	1	A0001	1	40	M	2011-12-12
1	1	A0001	1	40	M	2011-12-12
1	1	A0001	1	40	M	2011-12-12
1	1	A0001	1	40	M	2011-12-12
1	1	A0001	1	40	M	2011-12-12
2	1	A0002	1	30	M	2013-02-12
2	1	A0002	1	30	M	2013-02-12
2	1	A0002	1	30	M	2013-02-12
2	1	A0002	1	30	M	2013-02-12
2	1	A0002	1	30	M	2013-02-12
2	1	A0005	2	34	M	2017-02-01
2	1	A0005	2	34	M	2017-02-01
2	1	A0005	2	34	M	2017-02-01
2	1	A0005	2	34	M	2017-02-01
2	1	A0005	2	34	M	2017-02-01

Content

Cascading Style Sheets (CSS)

Hypertext Markup Language (HTML)

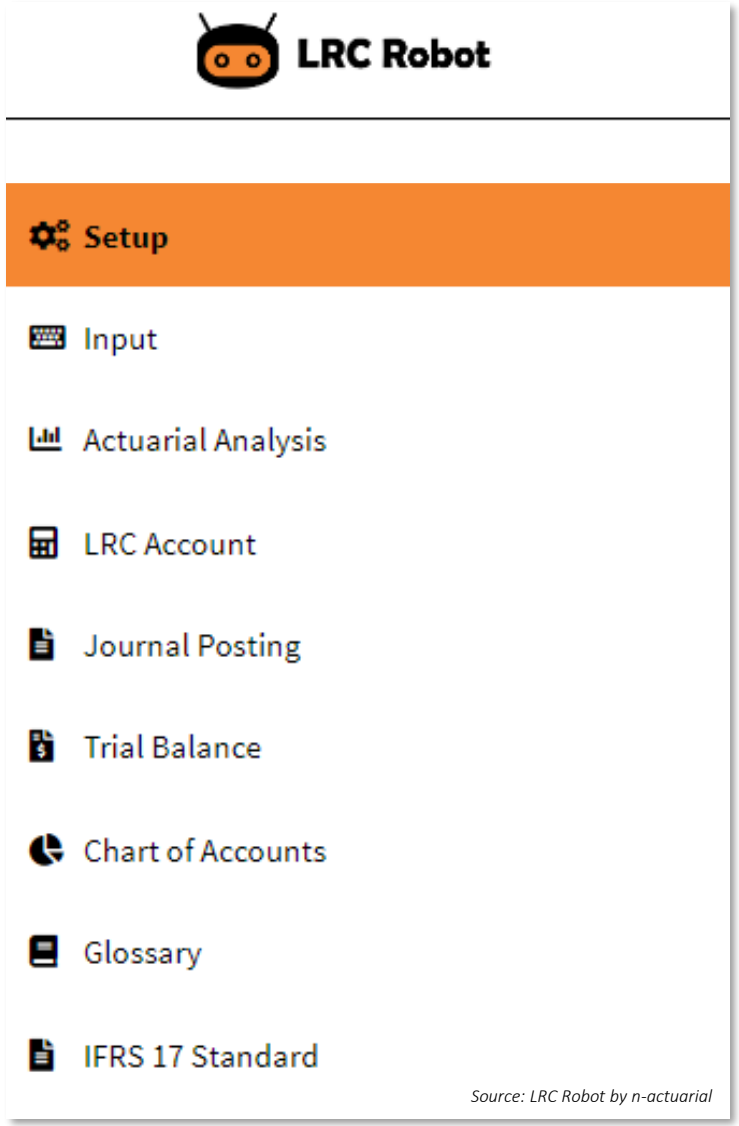
JavaScript

RMarkdown

Application Programming Interface (API)

……

```
output$sidebar <- renderUI({
  sidebarMenu(
        menuItem("Setup", tabName = "Setup",
                 icon = icon("cogs")),
        menuItem("Input", tabName = "Input",
                 icon = icon("keyboard")),
        menuItem("ActuarialAnalysis",
                 tabName = "ActuarialAnalysis",
                 icon = icon("chart-bar")),
        menuItem("Accounting", tabName = "Accounting",
                 icon = icon("calculator")),
        menuItem("Posting", tabName = "Posting",
                 icon = icon("file-alt")),
        menuItem("TrialBalance",
                 tabName = "TrialBalance,
                 icon = icon("file-invoice-dollar")),
        menuItem("ChartOfAccount",
                 tabName = "ChartOfAccount",
                 icon = icon("chart-pie")),
        menuItem("Glossary", tabName = "Glossary",
                 icon = icon("book")),
        menuItem("IFRS17Doc", tabName = "IFRS17Doc",
                 icon = icon("file-alt"))
  )
})
```



Source: LRC Robot by n-actuarial

Content

1. Run R Shiny app via **`profvis`** R package

```
library(profvis)

profvis({ runApp('R_shiny_app_dir') },
          prof_output='/profile_dir')
```

2. Interact with R Shiny app, and then close

3. Load profile

```
profvis(prof_input =
        '/output_dir/profile.Rprof')
```

Data Size (no. of rows)	No. of CPU	Time (sec)	Memory (MB)	Relative (time)
10,000	4	10.74	2,104.0	-
	8	9.36	2,239.2	1.15x
	12	8.99	2,123.9	1.19x
50,000	4	14.11	8,205.3	-
	8	13.13	8,479.6	1.07x
	12	13.10	8,559.6	1.08x
100,000	4	21.59	16,547.5	-
	8	20.05	16,125.1	1.08x
	12	19.89	15,849.7	1.09x
300,000	4	44.86	47,662.3	-
	8	44.86	48,182.6	1.00x
	12	44.67	48,421.6	1.00x
500,000	4	77.27	57,552.0	-
	8	78.76	57,366.9	0.98x
	12	77.33	59,538.8	1.00x

Table: Sample of R Shiny App performance test

Content

LRC Robot

Logout

English ไทย

- Setup
- Input
- Actuarial Analysis
- LRC Account
- Journal Posting
- Trial Balance
- Chart of Accounts
- Glossary
- IFRS 17 Standard

PAA GMM

Portfolio Class Sub Class

Gross Motoract Net Motoract RI Motoract

Functional Currency: THB

LRC Account	2020	Total
LRC excl. LC Opening Balance	**0.00**	**0.00**
Brought Forward	0.00	0.00
Adjustment	0.00	0.00
Insurance Revenue	**-35.52**	**-35.52**
Insurance Revenue	-35.52	-35.52
Insurance Revenue - Adjustment	0.00	0.00
Insurance Service Expense	**0.00**	**0.00**
Insurance Acquisition Cash Flows (Amortisation)	0.00	0.00
Insurance Finance Income or Expense	**318.15**	**318.15**
Interest Accretion - Investment Component	5.76	5.76
Interest Accretion - Insurance Revenue	19.36	19.36
Interest Accretion - Insurance Acquisition Cash Flows (Amortisation)	0.00	0.00
Change in Discount Rate - Insurance Revenue	228.03	228.03

Reporting Currency: USD

LRC Account	2020	Total
LRC excl. LC Opening Balance	**0.00**	**0.00**
Brought Forward	0.00	0.00
Adjustment	0.00	0.00
Insurance Revenue	**-1.14**	**-1.14**
Insurance Revenue	-1.14	-1.14
Insurance Revenue - Adjustment	0.00	0.00
Insurance Service Expense	**0.00**	**0.00**
Insurance Acquisition Cash Flows (Amortisation)	0.00	0.00
Insurance Finance Income or Expense	**10.18**	**10.18**
Interest Accretion - Investment Component	0.18	0.18
Interest Accretion - Insurance Revenue	0.62	0.62
Interest Accretion - Insurance Acquisition Cash Flows (Amortisation)	0.00	0.00
Change in Discount Rate - Insurance Revenue	7.30	7.30

Source: LRC Robot by n-actuarial

English

- Setup
- Input
- Actuarial Analysis
- LIC Account
- Journal Posting
- Trial Balance
- Chart of Accounts
- Underwriting Statement
- Glossary
- IFRS 17 Standard

Gross Motoract | Net Motoract | RI Motoract

ILR | PLR | IBF | PBF | ELR | EUL | IIL | IPL | IIB | IPB | Incurred Mack | Paid Mack | ALAE & ULAE | Selection | Results

Actuarial Calculations | Actuarial Projections

IFIC

Accident Year \ Development Years

	2014	2015	2016	2017	2018	2019	2020	Total
2021	191	607	10,093	12,561	11,100	44,499	161,360	240,411
2022	95	2,480	1,713	19,063	15,441	6,531	139,914	185,239
2023	48	1,240	9,330	3,236	23,434	9,085	20,534	66,907
2024		620	4,665	22,028	3,977	13,788	28,566	73,644
2025			2,333	11,014	32,494	2,340	43,352	91,533
2026				5,507	16,247	31,864	7,358	60,976
2027					8,124	15,932	110,206	134,261
2028						7,966	55,103	63,069
2029							27,551	27,551
Total	334	4,948	28,135	73,409	110,817	132,006	593,943	943,592

Showing 1 to 10 of 10 entries

IFPC

Accident Year \ Development Years

	2014	2015	2016	2017	2018	2019	2020	Total
2021	191	764	14,947	24,389	27,291	145,603	409,593	622,777

Source: LIC Robot by n-actuarial

ReACC

Logout

- Overview
- Results
- Accounts
- Input Data
- Checks
- Variables
- Tables
- Cessions
- How It Works
- License

Source: ReACC by n-actuarial

Setting

Choose Tranche:

T1 T2 Total

Choose Reinsurer:

C Re B Re All

Accounts

Reinsurance accounts from 01/06/2018 to 30/06/2018

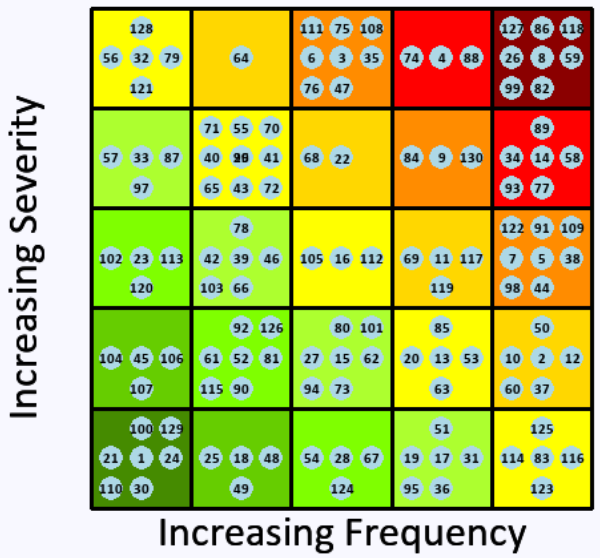
Tranche	Total	1		2	
Tranche Name	**Total**	**T1**		**T2**	
Reinsurer	**All**	**C Re**	**All**	**B Re**	**All**
Accounts Statement					
Reinsurance Premiums	1,997.14	407.97	407.97	1,589.17	1,589.17
(-) Ceding Commission	240.51	81.59	81.59	158.92	158.92
(-) Reinsurance Claims	0.00	0.00	0.00	0.00	0.00
(-) Premium Tax or Levies	0.00	0.00	0.00	0.00	0.00
Results before Profit Share	1,756.63	326.38	326.38	1,430.25	1,430.25
(-) Profit Commission	120.49	120.49	120.49	0.00	0.00
(-) Profit Tax or Levies	0.00	0.00	0.00	0.00	0.00
Results after Profit Share	1,636.14	205.88	205.88	1,430.25	1,430.25
Profit Commission Statement					
Results before Profit Share	1,756.63	326.38	326.38	1,430.25	1,430.25
(-) Amounts Brought Forward	1,787,860.28	675.64	675.64	1,787,184.64	1,787,184.64
(-) Interest on Amounts Brought Forward	7,346.95	2.36	2.36	7,344.59	7,344.59
(-) Profit Share Expenses	81.59	81.59	81.59	0.00	0.00

Source: RiskHeat by n-actuarial

n - a c t u a r i a l

Risk Heat

Heat Map



Upload Risk Register

Browse... Risk Heat Map.csv

Upload complete

Remove Data Uploaded

Upload Report Required

Browse... Criteria.csv

Upload complete

Remove Data Uploaded

Download Reports

Risk Register

Show all rows | Column visibility | Search:

ID	Risk.Type	Description	Elaboration	Frequency	Severity	Category	Direction	Velocity	Risk.Score	Risk.Owner	Mitigation	Timestamp
1	Executive Support	Executives fail to support project	The project team may lack the authority to achieve project objectives. In such cases, executive management support is fundamental to project success. When this doesn't materialize the project fails.	1	1	Strategic	Rising Steeply	Very Fast	1	D	Accept the Risk	2017-04-26
2	Executive Support	Executives become disengaged with project	Executive management disregards project communications and meetings.	5	2	Strategic	Static	Normal	10	C	Avoid the Risk	2012-10-13
3	Executive Support	Conflict between executive stakeholders disrupts project	Members of executive management are combative to the project or there is a disagreement over project issues at the executive level.	3	5	Financial	Rising	Normal	15	B	Avoid the Risk	2012-11-05

SOCIETY OF ACTUARIES

2022 ASIA-PACIFIC SYMPOSIUM

Thank You

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