

Developing Actuarial Applications Using R Shiny

June 2022

PRESENTERS:

Nicholas Yeo Chee Lek

FSA

Founder and Actuary of
Nicholas Actuarial Solutions

Debbie Ooi (Min Jyeh)

Actuarial Analyst of
Nicholas Actuarial Solutions

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- **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.

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2. Building R Shiny App



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4. R Shiny App Performance



5. Gallery of R Shiny App

Content



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How R Shiny Works?



Server Instructions



User Interface (UI)



The screenshot shows the LRC Robot web application interface. It features a sidebar menu on the left with options like 'Setup', 'Input', 'Actuarial Analysis', 'LRC Account', 'Journal Posting', 'Trial Balance', 'Chart of Accounts', 'Glossary', and 'IFRS 17 Standard'. The main content area displays two tables side-by-side, comparing financial data for 'Functional Currency: THB' and 'Reporting Currency: USD'. The tables show various line items such as 'LRC Account', 'LRC excl. LC Opening Balance', 'Brought Forward', 'Adjustment', 'Insurance Revenue', 'Insurance Revenue - Adjustment', 'Insurance Service Expense', 'Insurance Acquisition Cash Flows (Amortisation)', 'Insurance Finance Income or Expense', 'Interest Accretion - Investment Component', 'Interest Accretion - Insurance Acquisition Cash Flows (Amortisation)', and 'Change in Discount Rate - Insurance Revenue'.

Functional Currency: THB			Reporting Currency: USD		
	2020	Total		2020	Total
LRC Account			LRC Account		
LRC excl. LC Opening Balance	0.00	0.00	LRC excl. LC Opening Balance	0.00	0.00
Brought Forward	0.00	0.00	Brought Forward	0.00	0.00
Adjustment	0.00	0.00	Adjustment	0.00	0.00
Insurance Revenue	-35.52	-35.52	Insurance Revenue	-1.14	-1.14
Insurance Revenue - Adjustment	-35.52	-35.52	Insurance Revenue - Adjustment	-1.14	-1.14
Insurance Revenue - Adjustment	0.00	0.00	Insurance Revenue - Adjustment	0.00	0.00
Insurance Service Expense	0.00	0.00	Insurance Service Expense	0.00	0.00
Insurance Acquisition Cash Flows (Amortisation)	0.00	0.00	Insurance Acquisition Cash Flows (Amortisation)	0.00	0.00
Insurance Finance Income or Expense	318.15	318.15	Insurance Finance Income or Expense	10.18	10.18
Interest Accretion - Investment Component	5.76	5.76	Interest Accretion - Investment Component	0.18	0.18
Interest Accretion - Insurance Revenue	19.36	19.36	Interest Accretion - Insurance Revenue	0.62	0.62
Interest Accretion - Insurance Acquisition Cash Flows (Amortisation)	0.00	0.00	Interest Accretion - Insurance Acquisition Cash Flows (Amortisation)	0.00	0.00
Change in Discount Rate - Insurance Revenue	226.03	226.03	Change in Discount Rate - Insurance Revenue	7.30	7.30

Content



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```
library(shiny)
```

← R Shiny Package

```
ui <- dashboardPage()
```

← Visual Elements

```
server <- function(input, output) {}
```

← Logic Defined

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

← 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

```

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

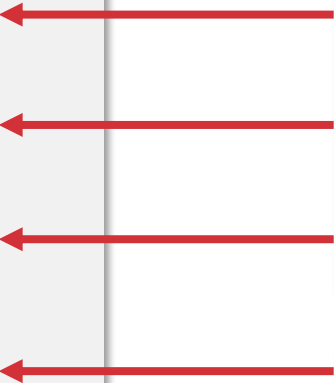
File input

Company Name:

Start Report Date:

End Report Date:

Upload Input Files



```

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

```

Reactive function

```

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

```

Render function

```

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

```

Download handler

```

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

```

Output function



Show 10 entries

Source: LRC Robot by n-actuarial

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)

```

Heat Map

Increasing Severity



Increasing Frequency

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 == ...])
  .
  .
  .
}

```

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

Before manual adjustment

After manual adjustment

```

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

```

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

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Cascading Style
Sheets (CSS)

Hypertext
Markup Language
(HTML)

JavaScript

RMarkdown

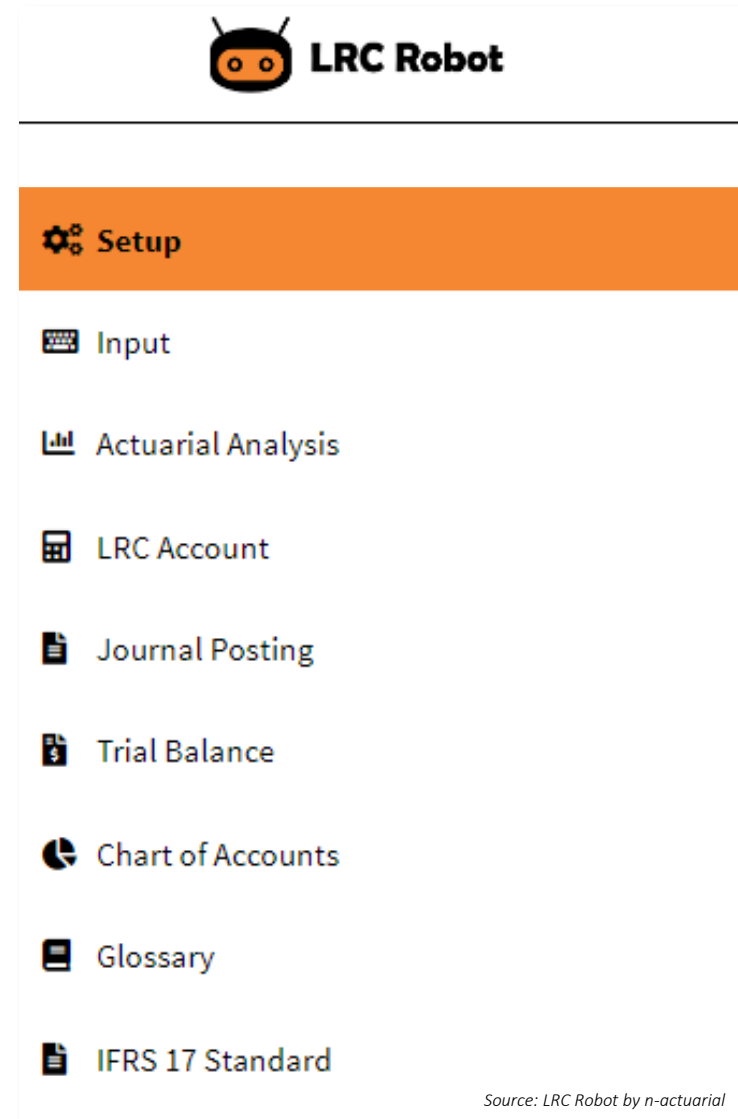
Application
Programming
Interface (API)

.....

```

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"))
  )
})

```



Content



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5. Gallery of R Shiny App

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



1. How R Shiny Works



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4. R Shiny App Performance



5. Gallery of R Shiny App

- 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

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

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
<i>(-) Ceding Commission</i>	240.51	81.59	81.59	158.92	158.92
<i>(-) Reinsurance Claims</i>	0.00	0.00	0.00	0.00	0.00
<i>(-) Premium Tax or Levies</i>	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
<i>(-) Profit Commission</i>	120.49	120.49	120.49	0.00	0.00
<i>(-) Profit Tax or Levies</i>	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
<i>(-) Amounts Brought Forward</i>	1,787,860.28	675.64	675.64	1,787,184.64	1,787,184.64
<i>(-) Interest on Amounts Brought Forward</i>	7,346.95	2.36	2.36	7,344.59	7,344.59
<i>(-) Profit Share Expenses</i>	81.59	81.59	81.59	0.00	0.00

Source: ReACC by n-actuarial



Heat Map

Increasing Severity



Increasing Frequency

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

Thank You

June 2022

PRESENTERS:

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FIA FASM FSA FSAS FSAT
Founder and Actuary of
Nicholas Actuarial Solutions

Debbie Ooi (Min Jyeh)

Actuarial Analyst of
Nicholas Actuarial Solutions