PartnerRe

Long Term Protection Model in R

Dr. Urszula Gasser, Senior Pricing Actuary

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Disclaimer

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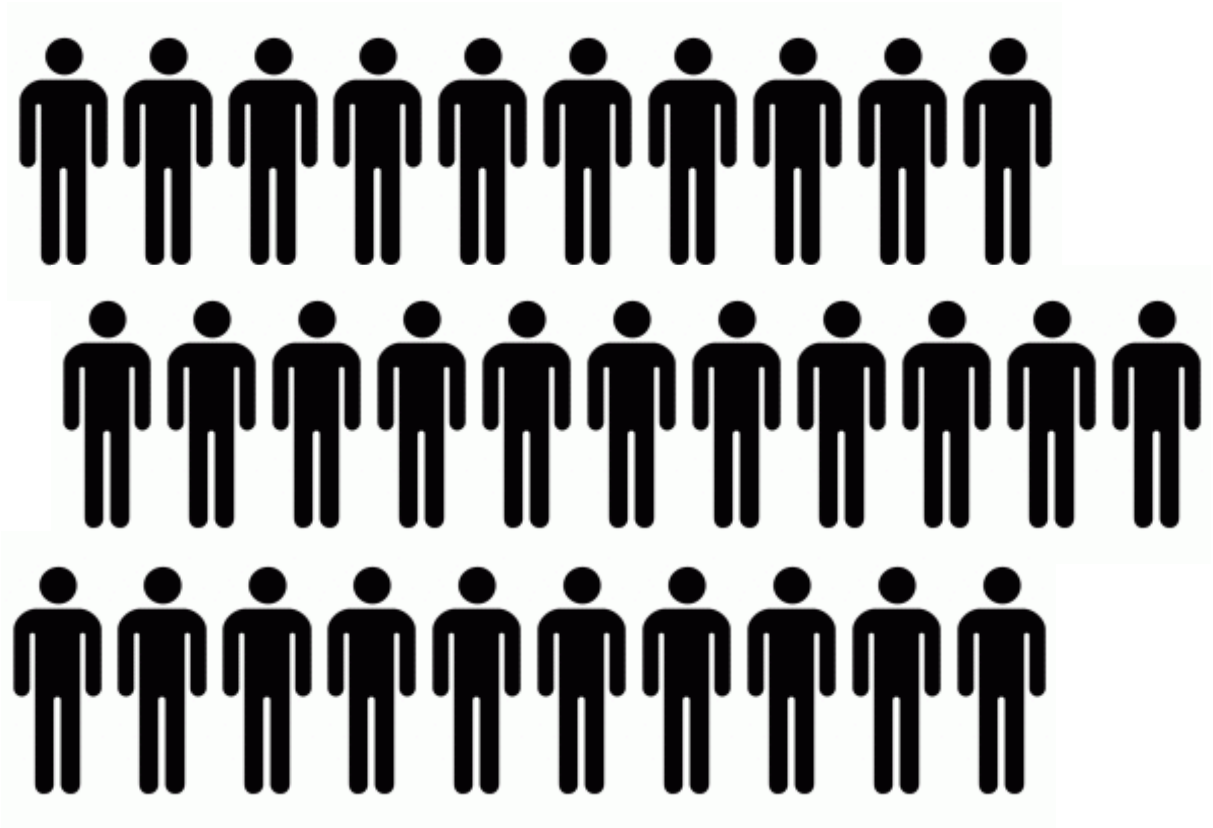
The need

Life insurance

Gives protection against loss resulting from death (or serious illness) of an insured



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Life insurance

Gives protection against loss resulting from death (or serious illness) of an insured

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Life reinsurer needs to…

model underlying risk → need for specialized tools

The model

What about Mr Bloggs?

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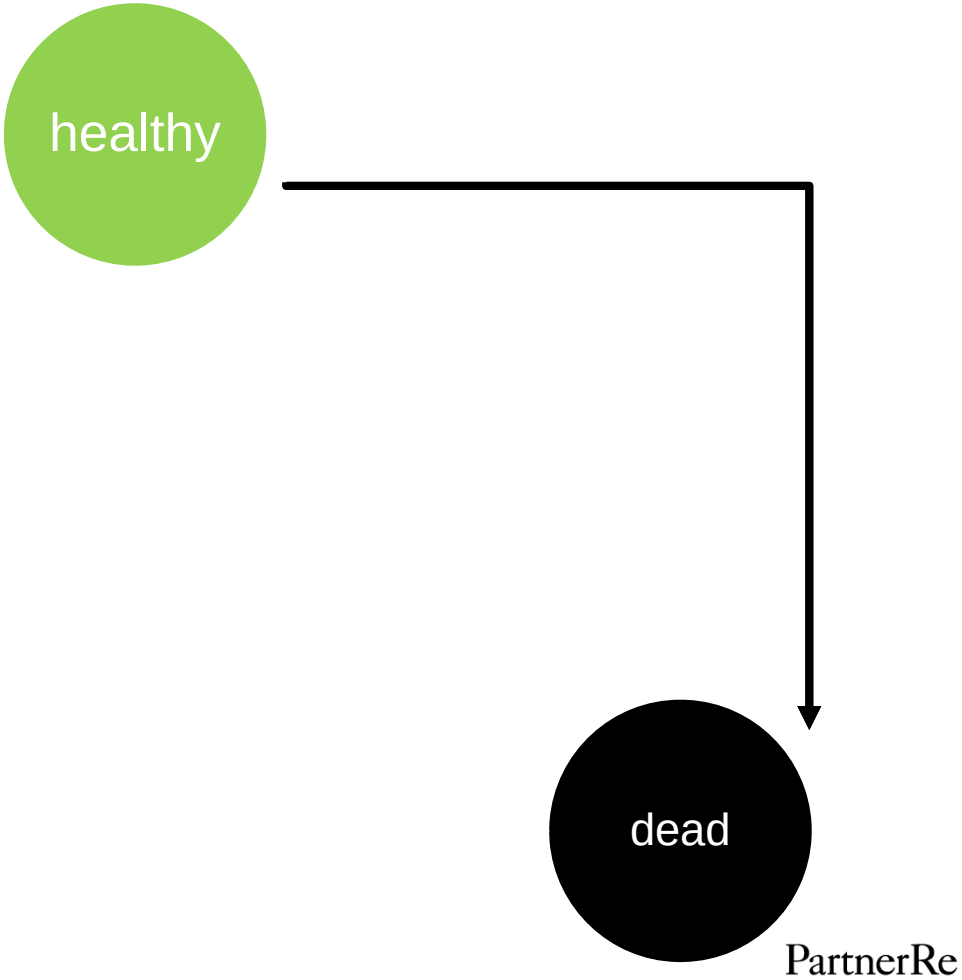

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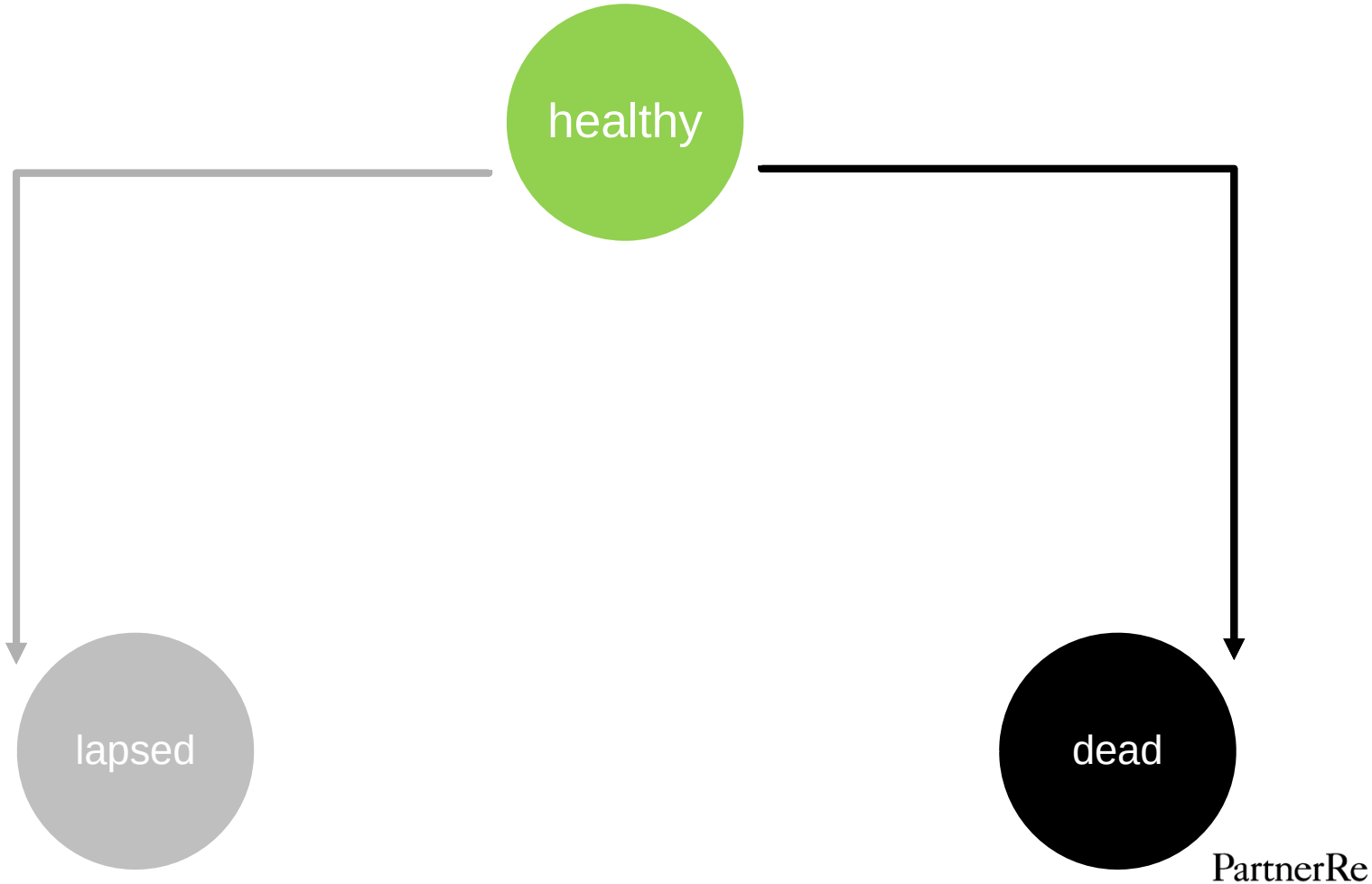

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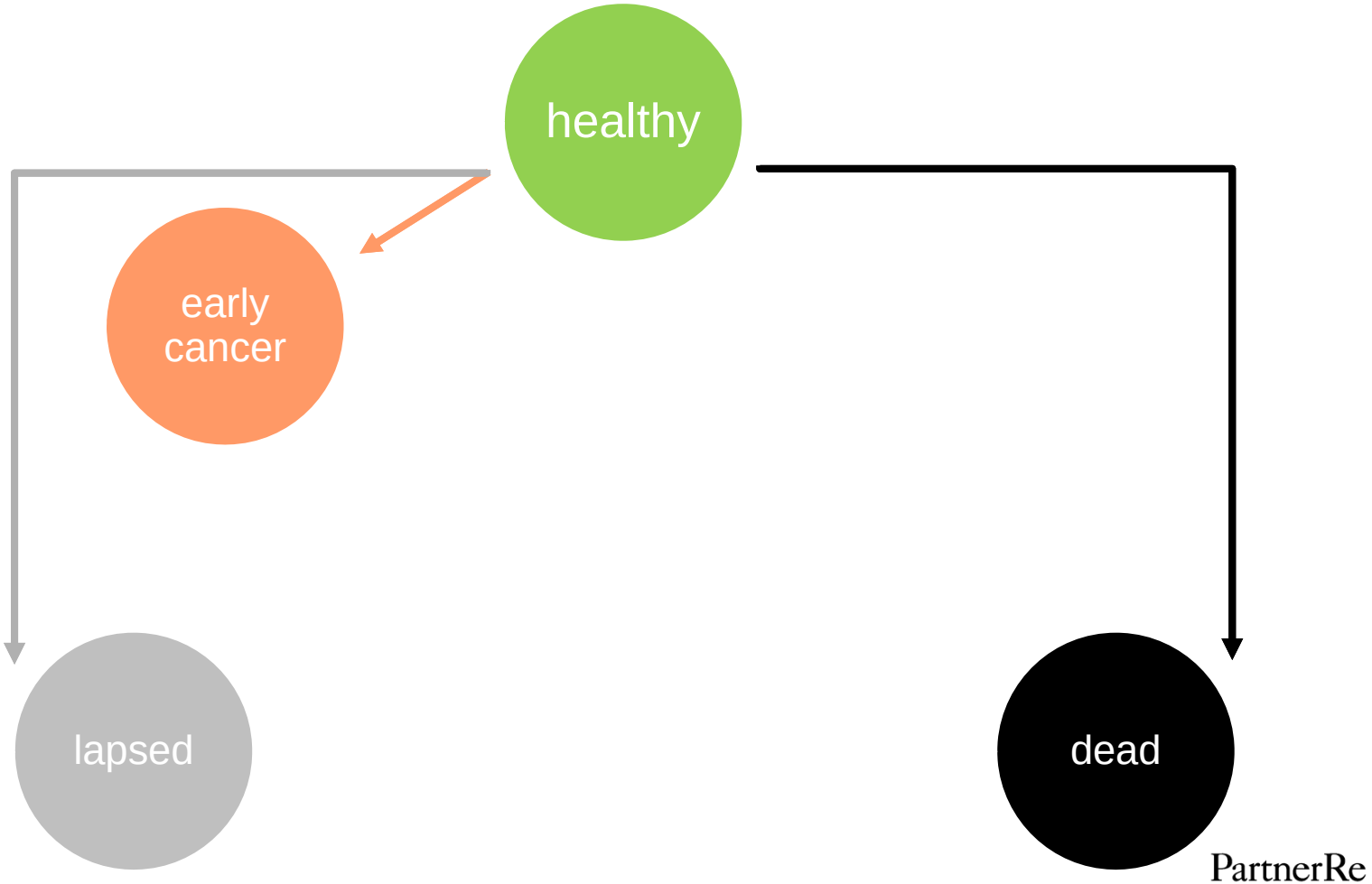

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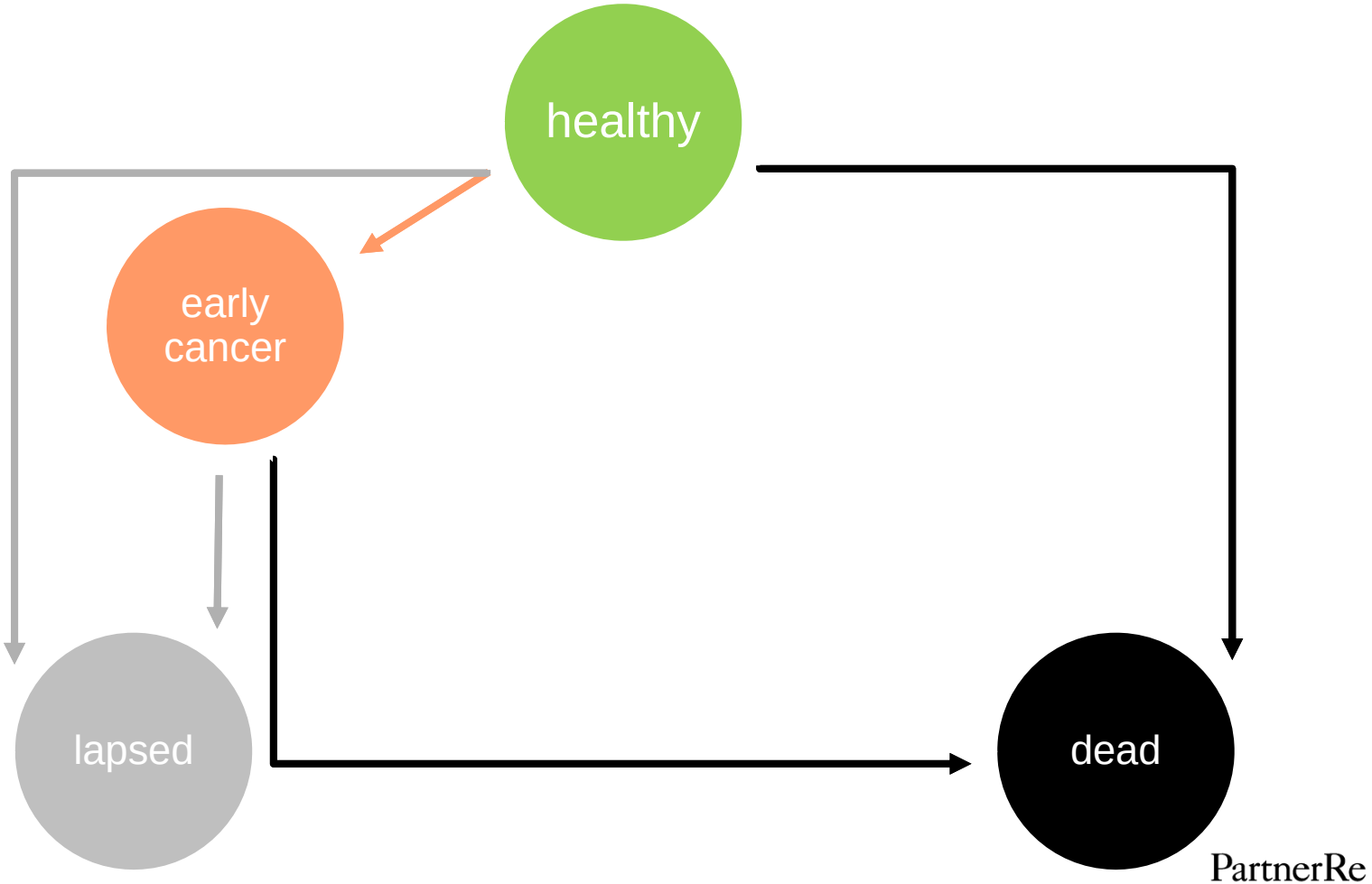

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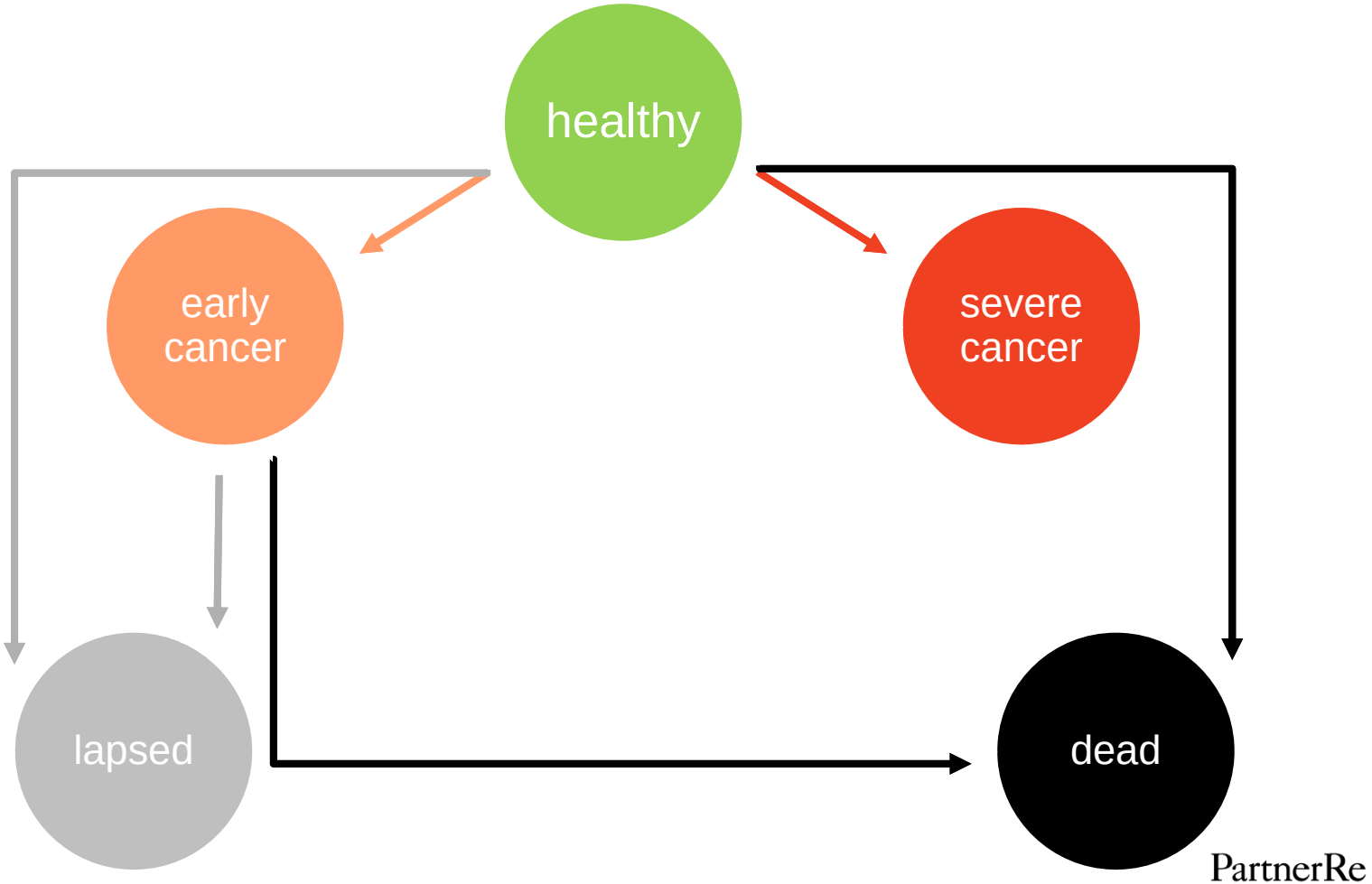

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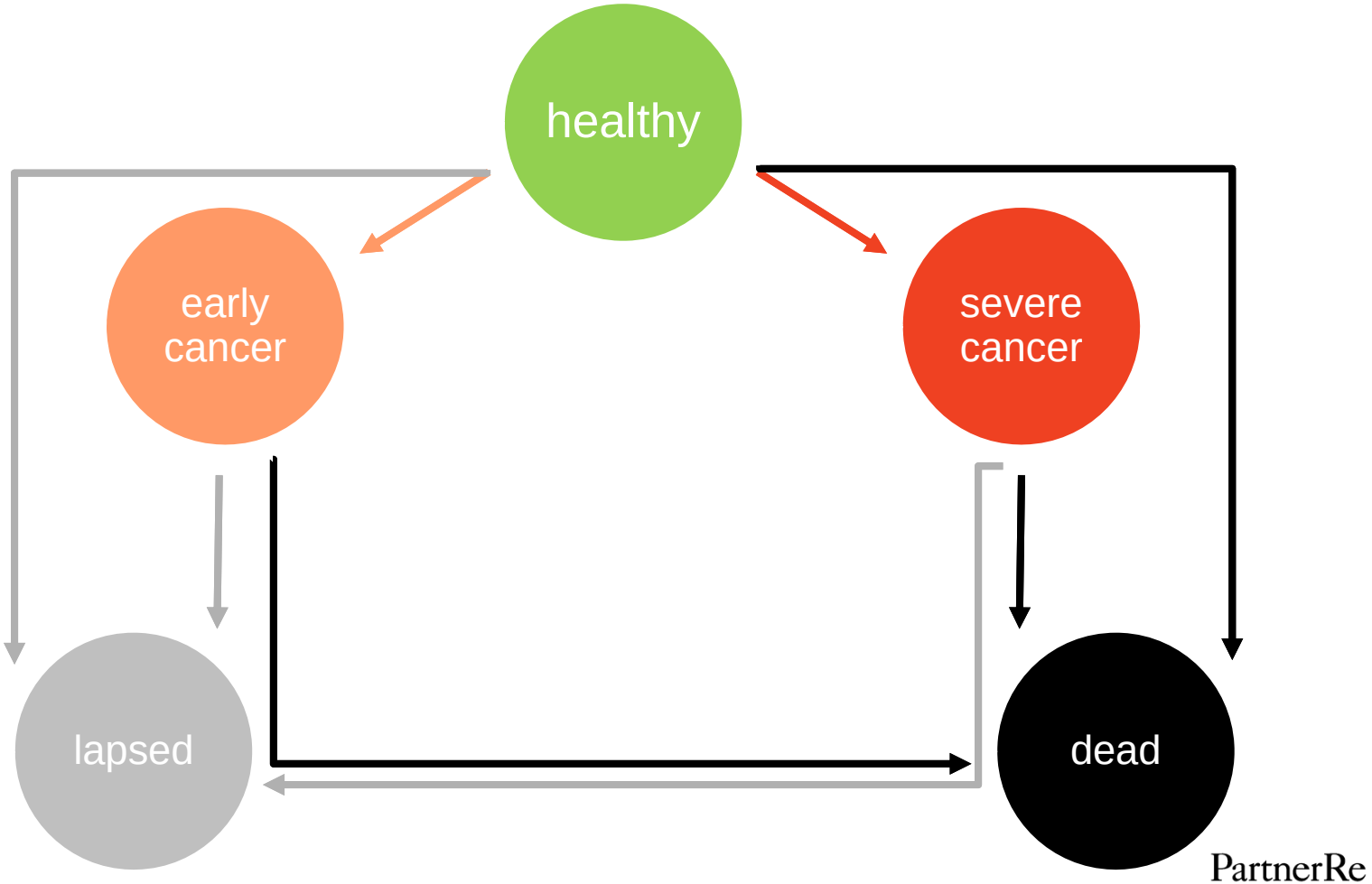

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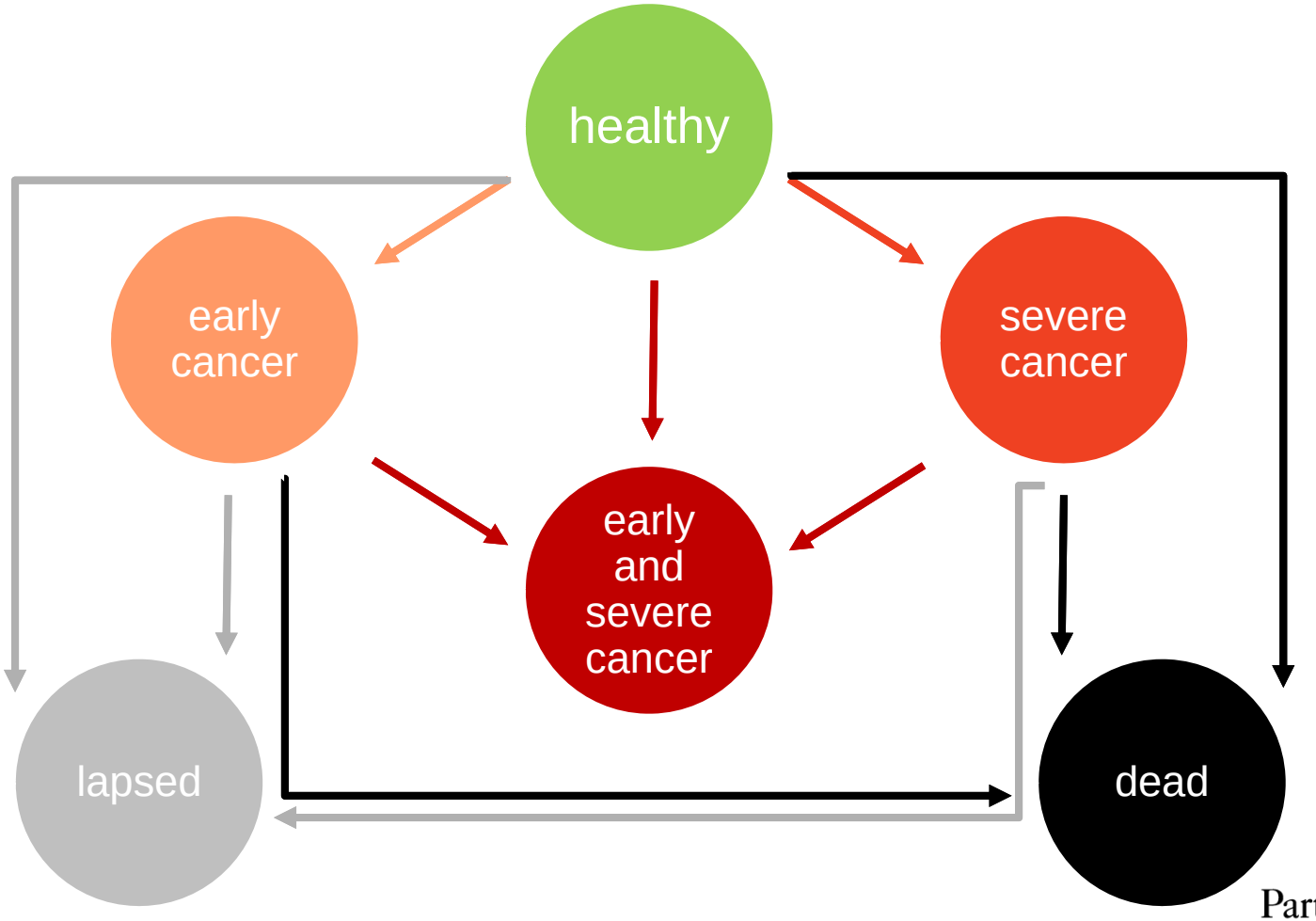

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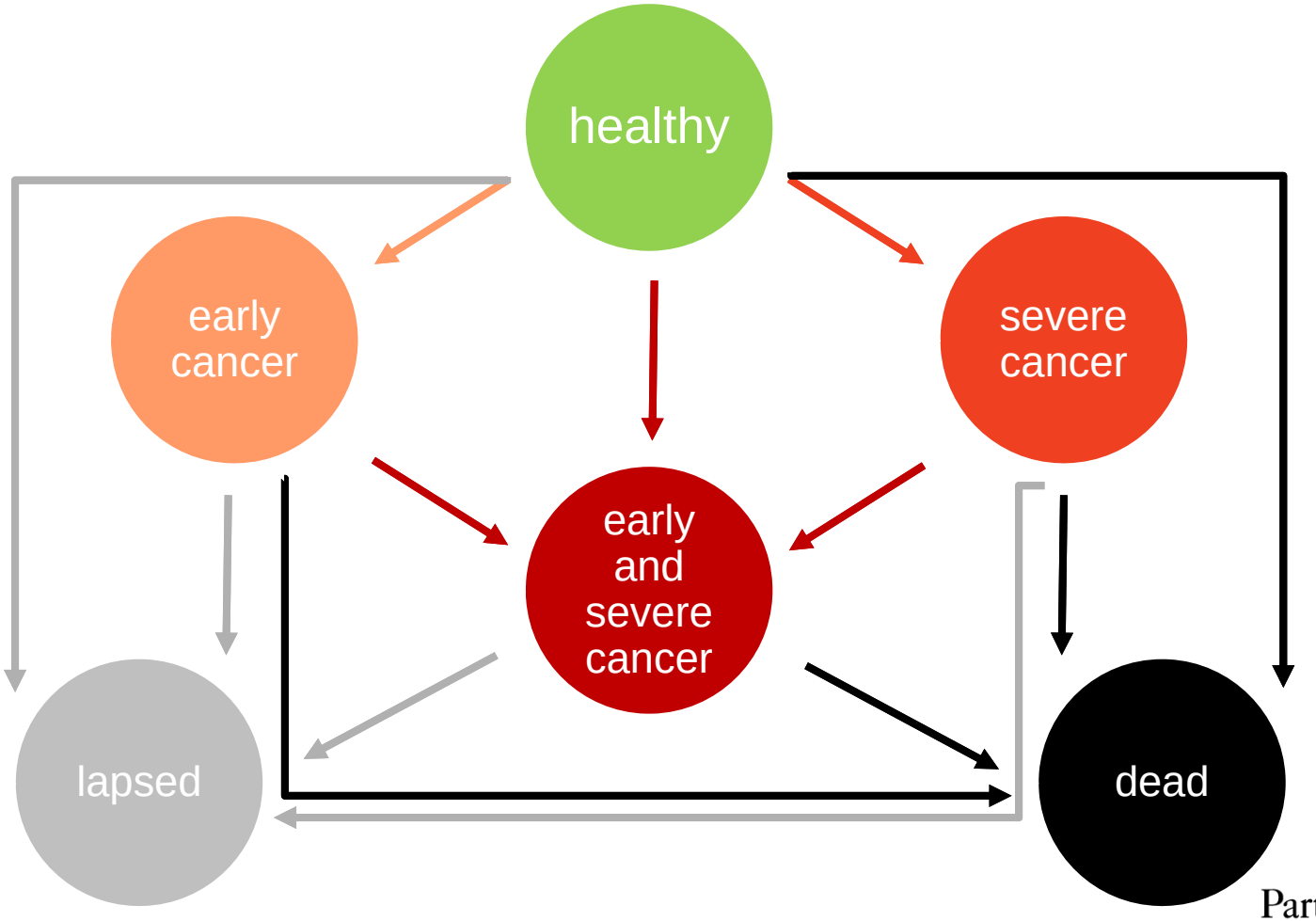

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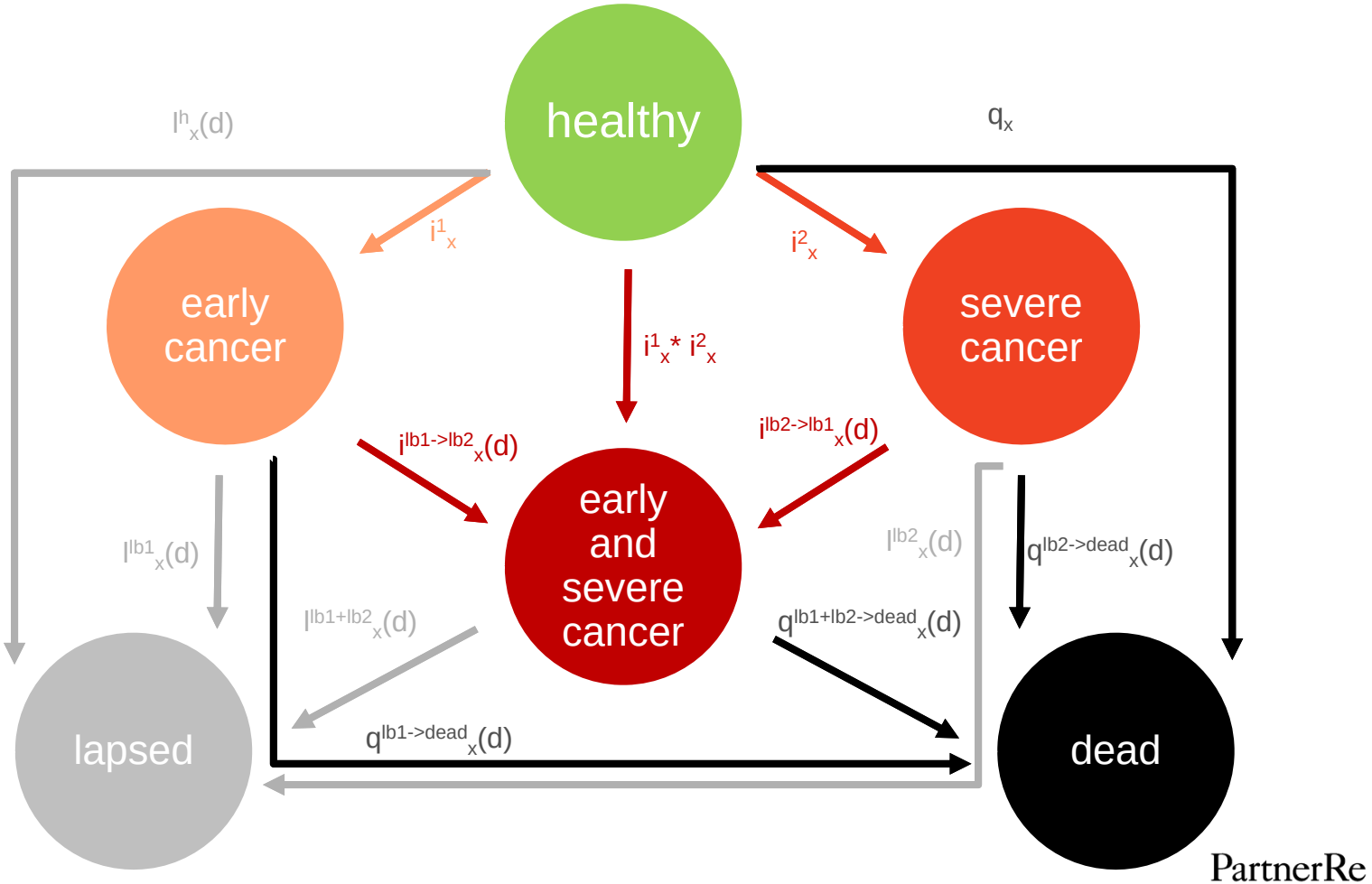

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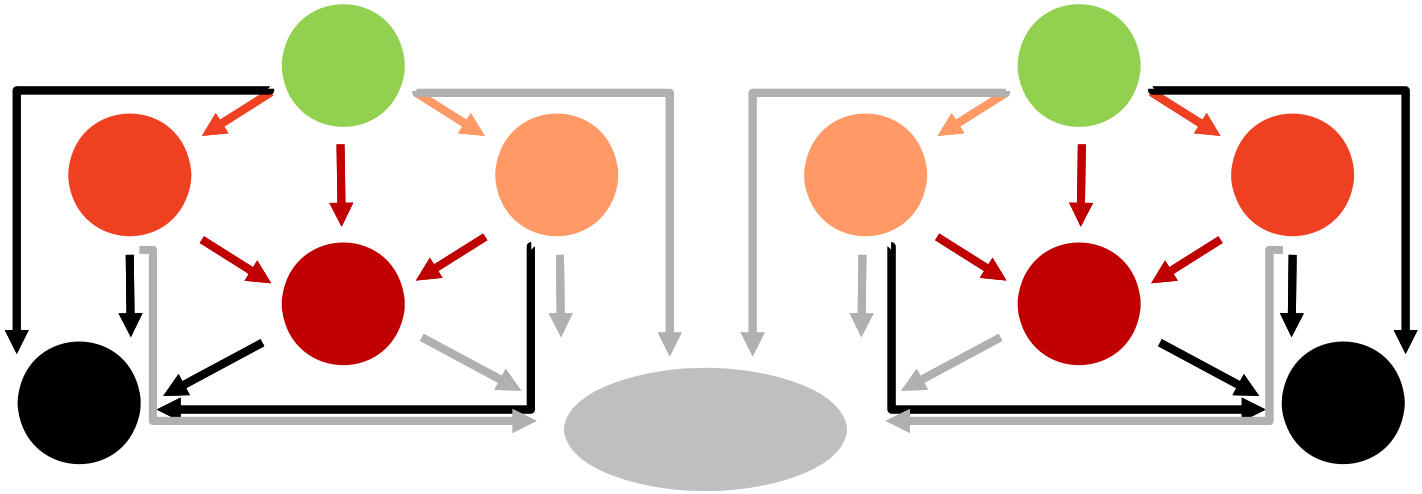
q_x, i_x, l_x – mortality rate, incidence rate, lapse rate
d – duration (months) in given state

And what about Mrs Bloggs?



To model Mr & Mrs Bloggs policy

we decided to build our own, **Long Term Protection Model** for pricing

The tool

LTPM pricing tool needs to be

- **User friendly**
  - Easy to access
  - Simple to set-up
  - Fast to calculate
  - Straightforward to interpret
- **Flexible**
- **Stable**
- **Secure**
- **Auditable**

We decided to do it in R

as opposed to most tools used in the re/insurance industry,

because these come often with:

- Legacy issues (too heavy)
- Calculation constraints (some things are not possible)
- Access issues (desktop versions, use of “workers”, external clouds)
- Transparency issues (black-box)
- Maintenance issues (costly upgrade, adaptation)

Why R?

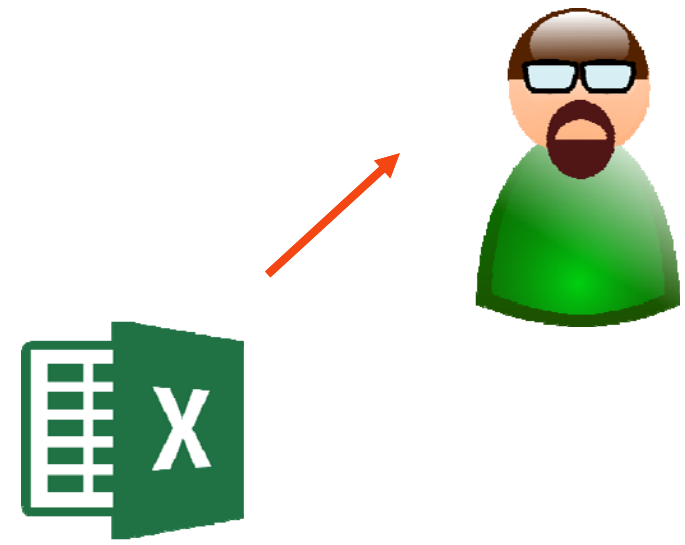
- **Becoming the standard analytics tool at university level and in many industries**
- **Free**
- **Open source**
- **Meets our needs**
  - Fast
  - Flexible
- **Reduces the number of platforms we maintain**

R is an excellent fit…

… but we also need an infrastructure to support all the tool requirements

The workflow

First, let's look at the steps in the calculation



Input data

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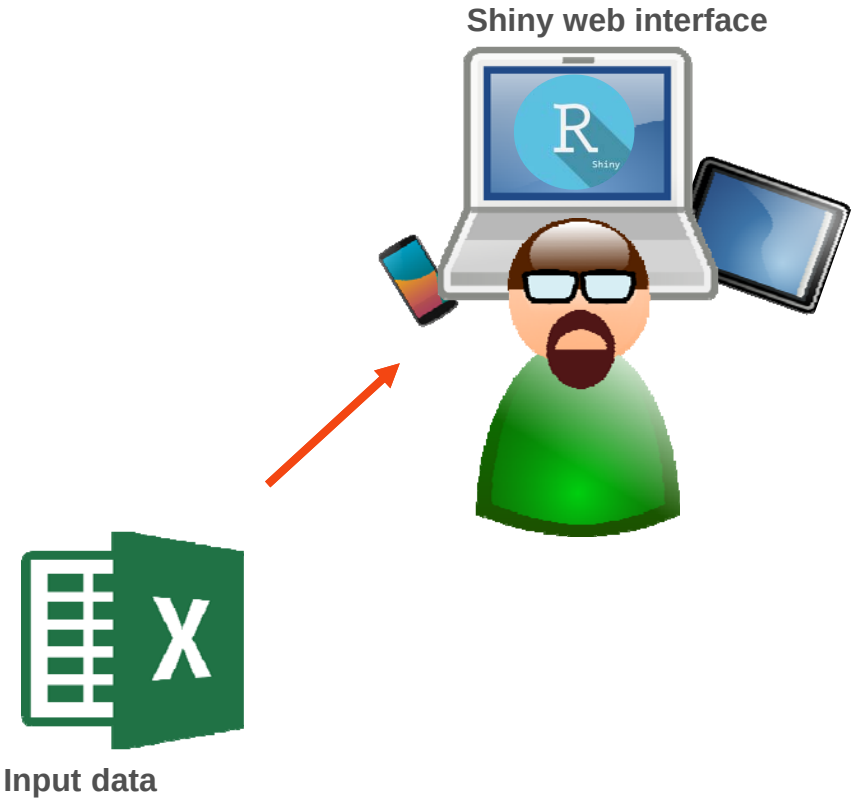
Steps in the calculation



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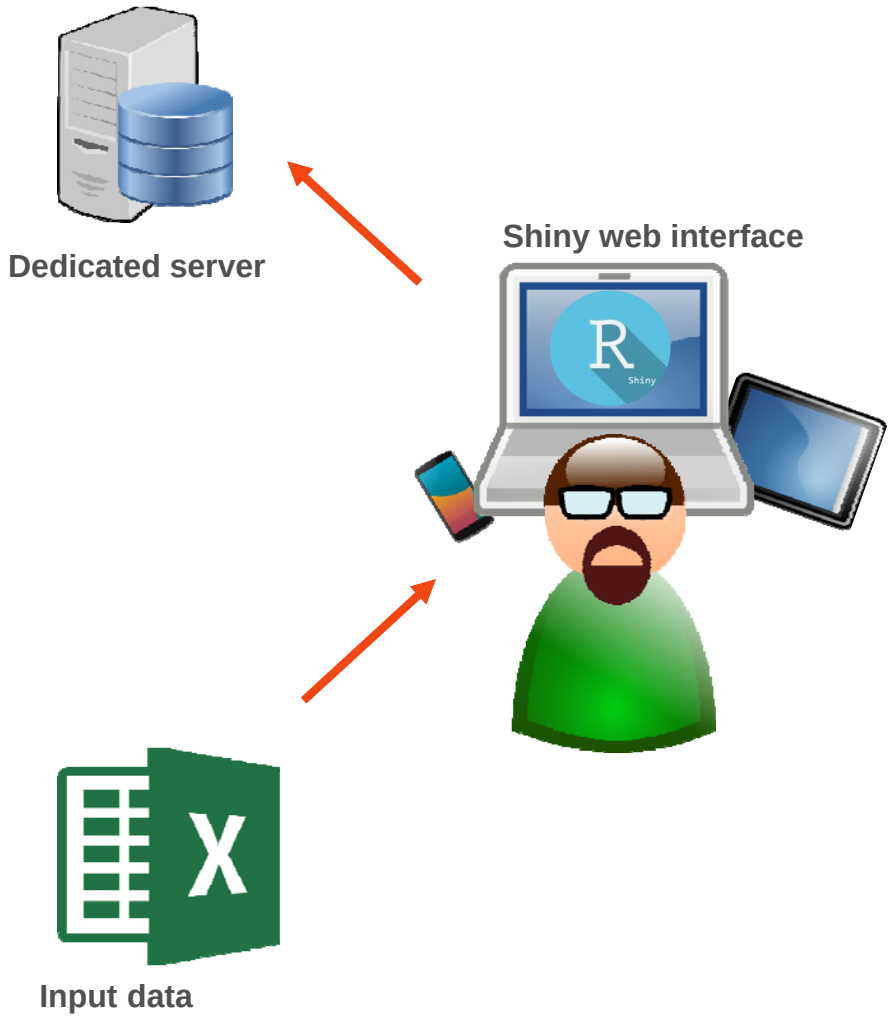

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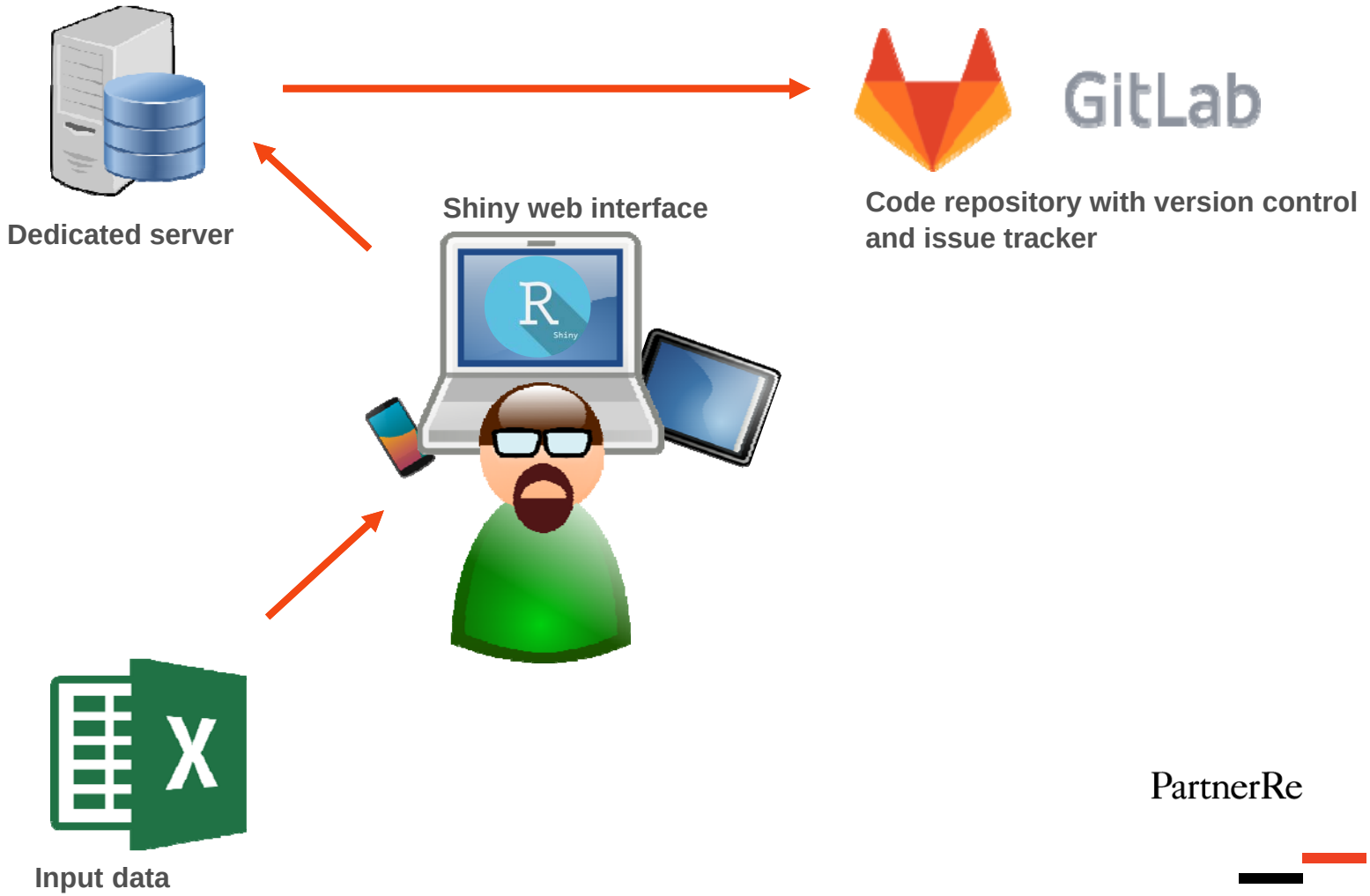

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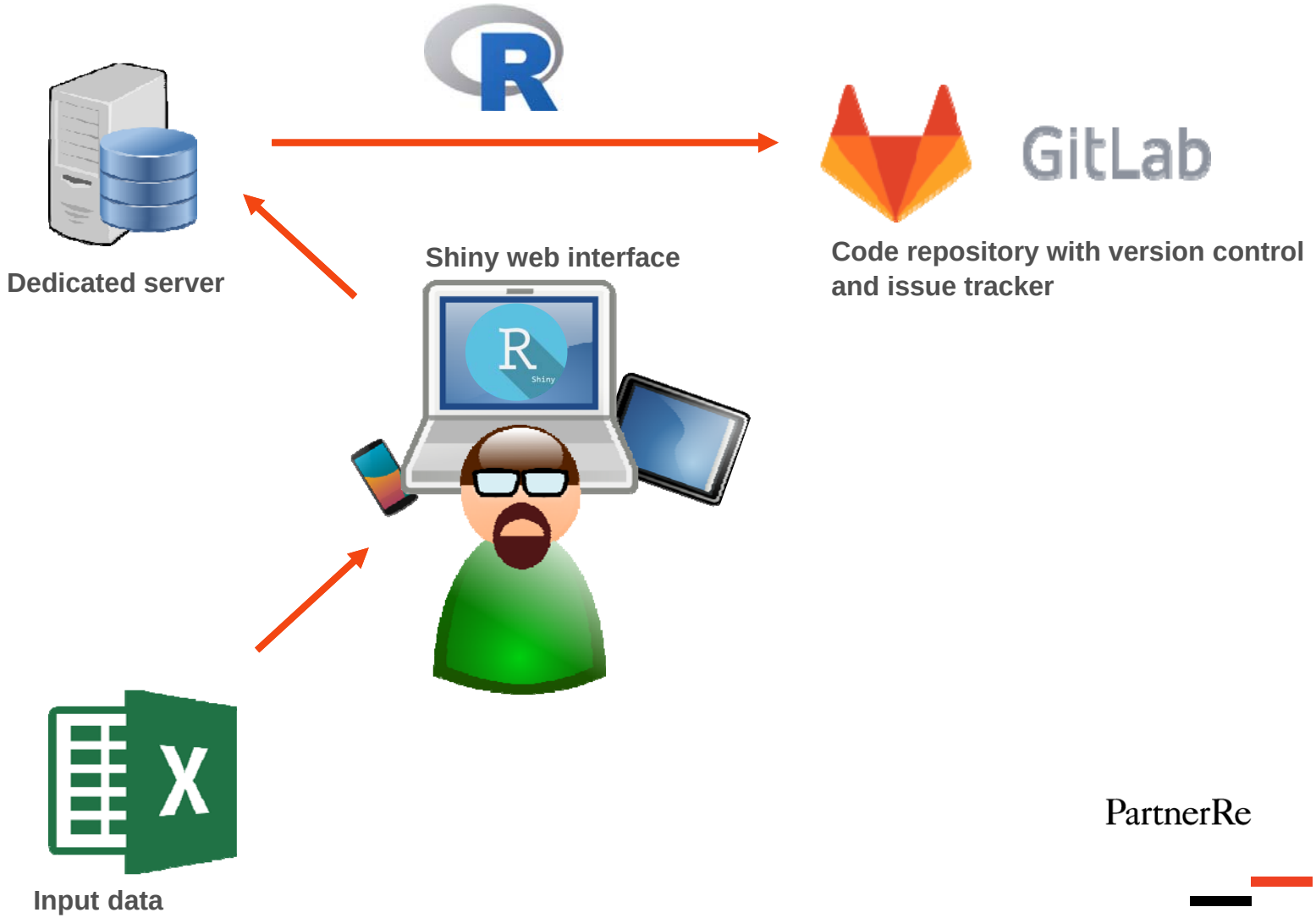

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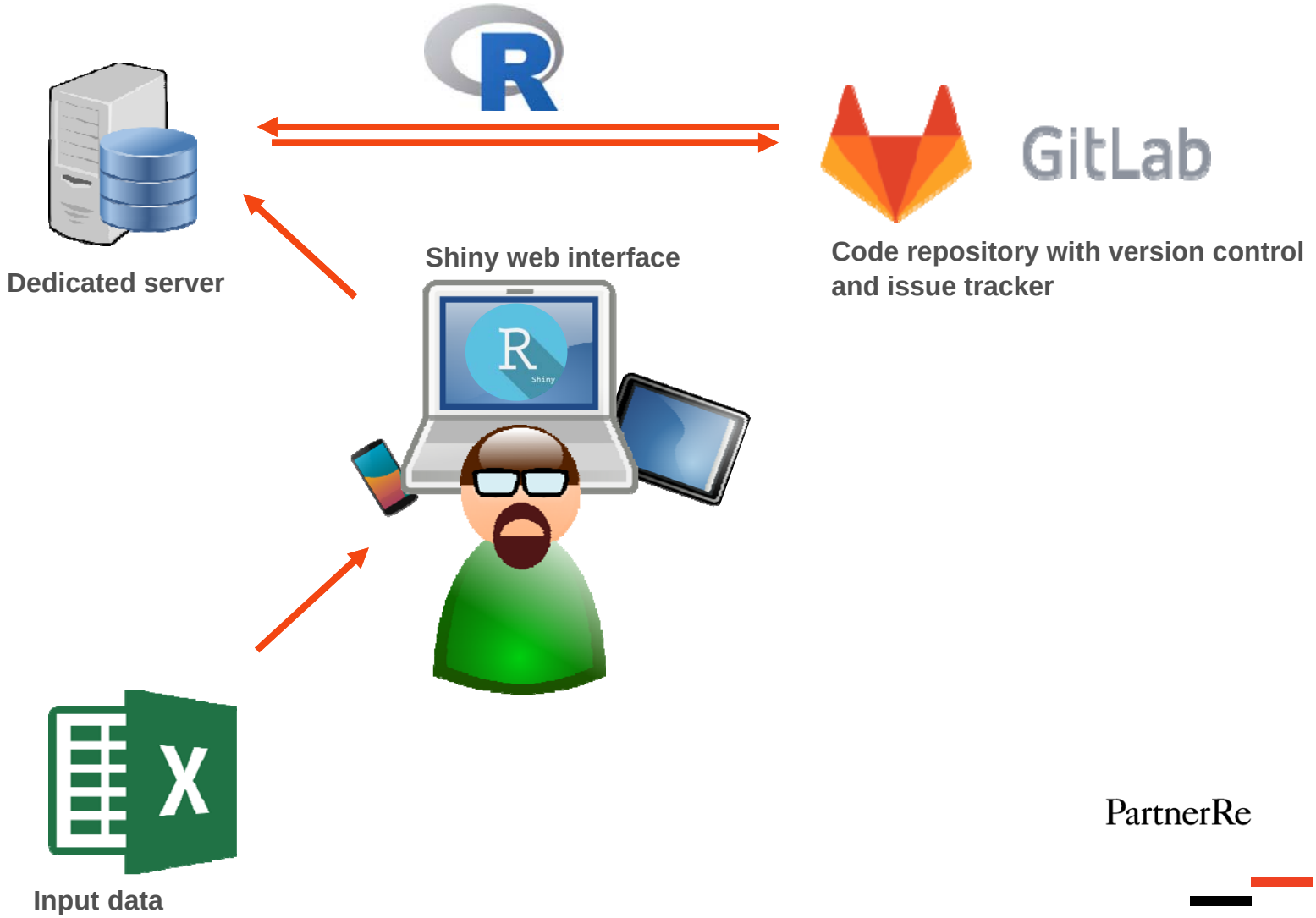

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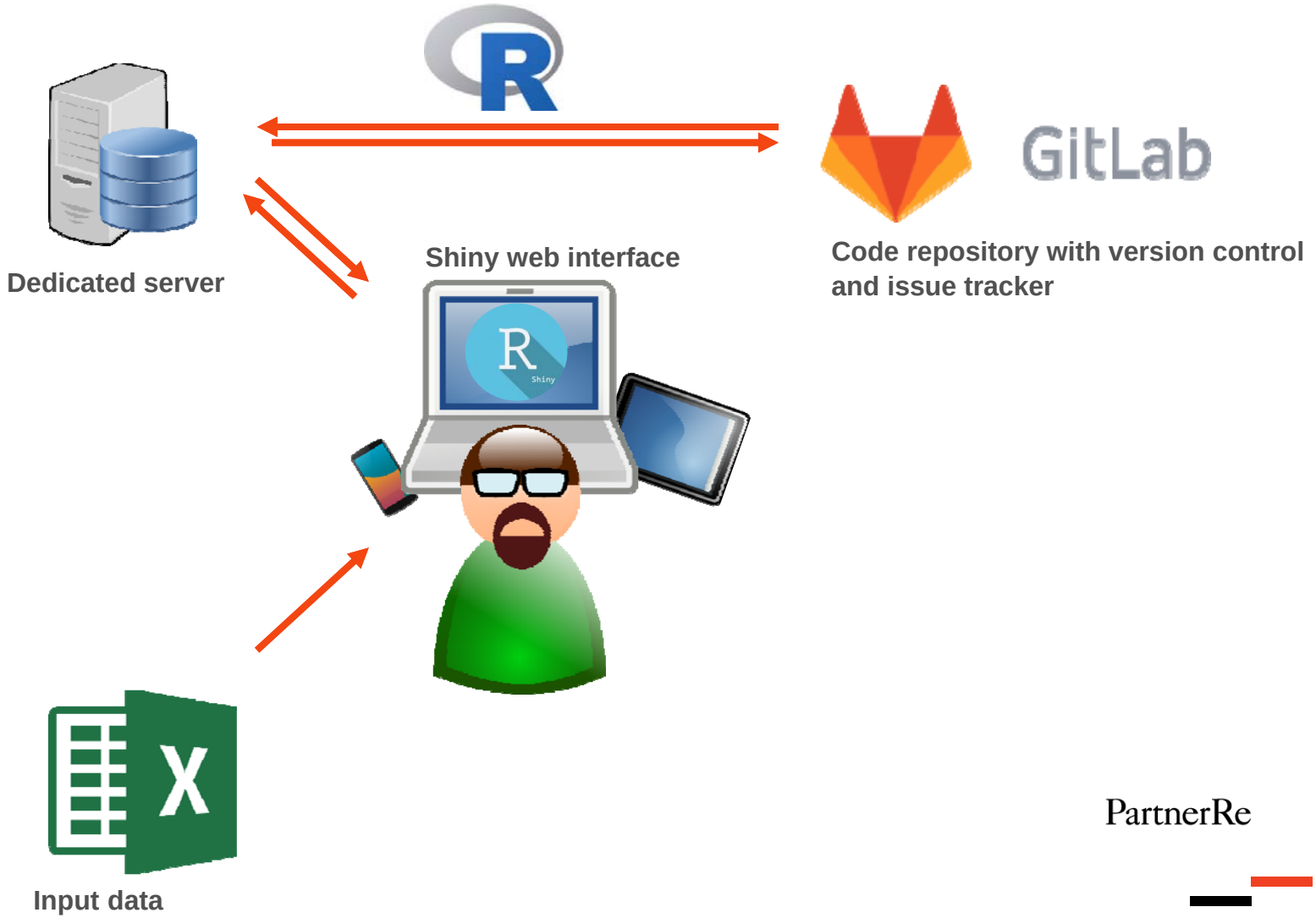

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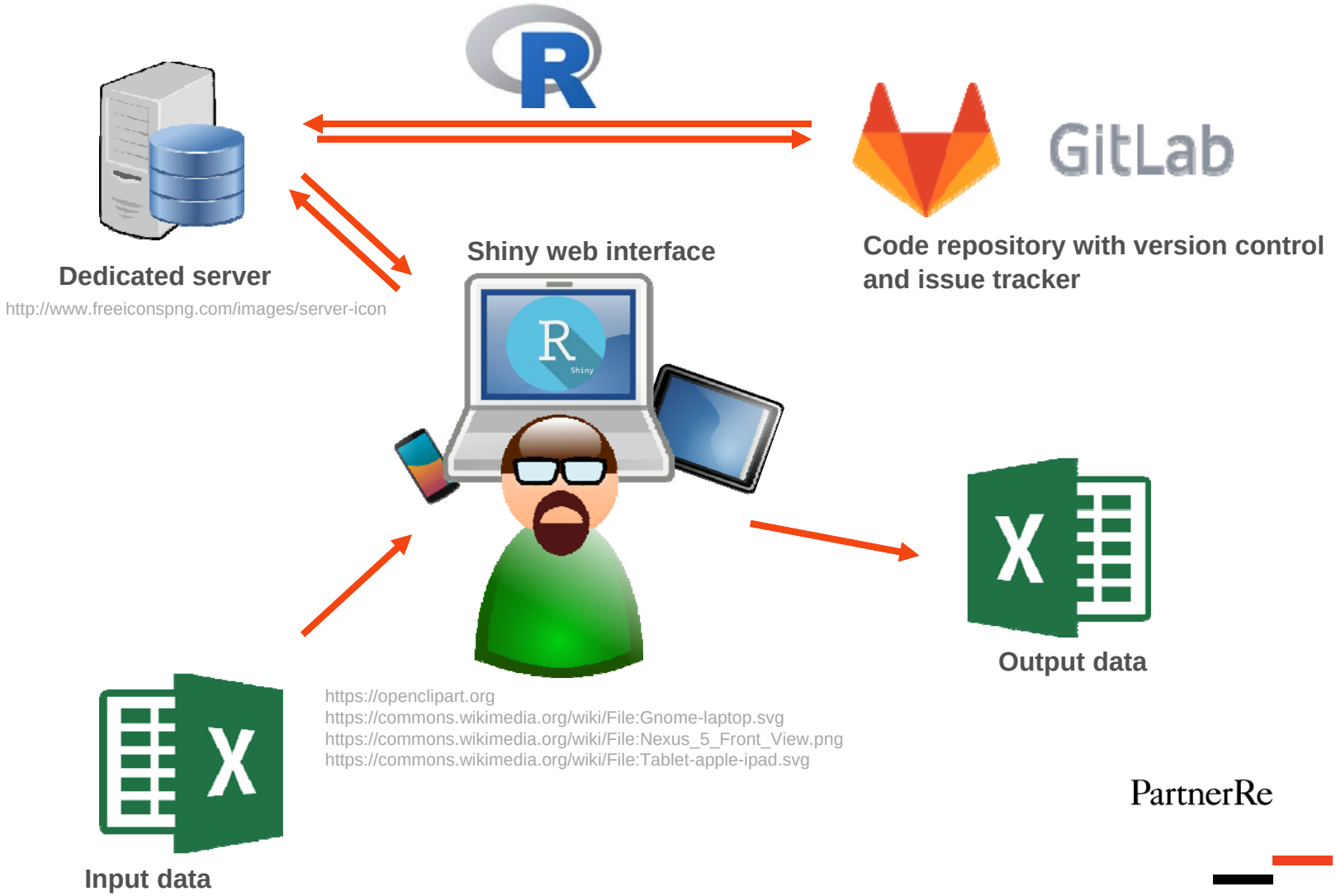
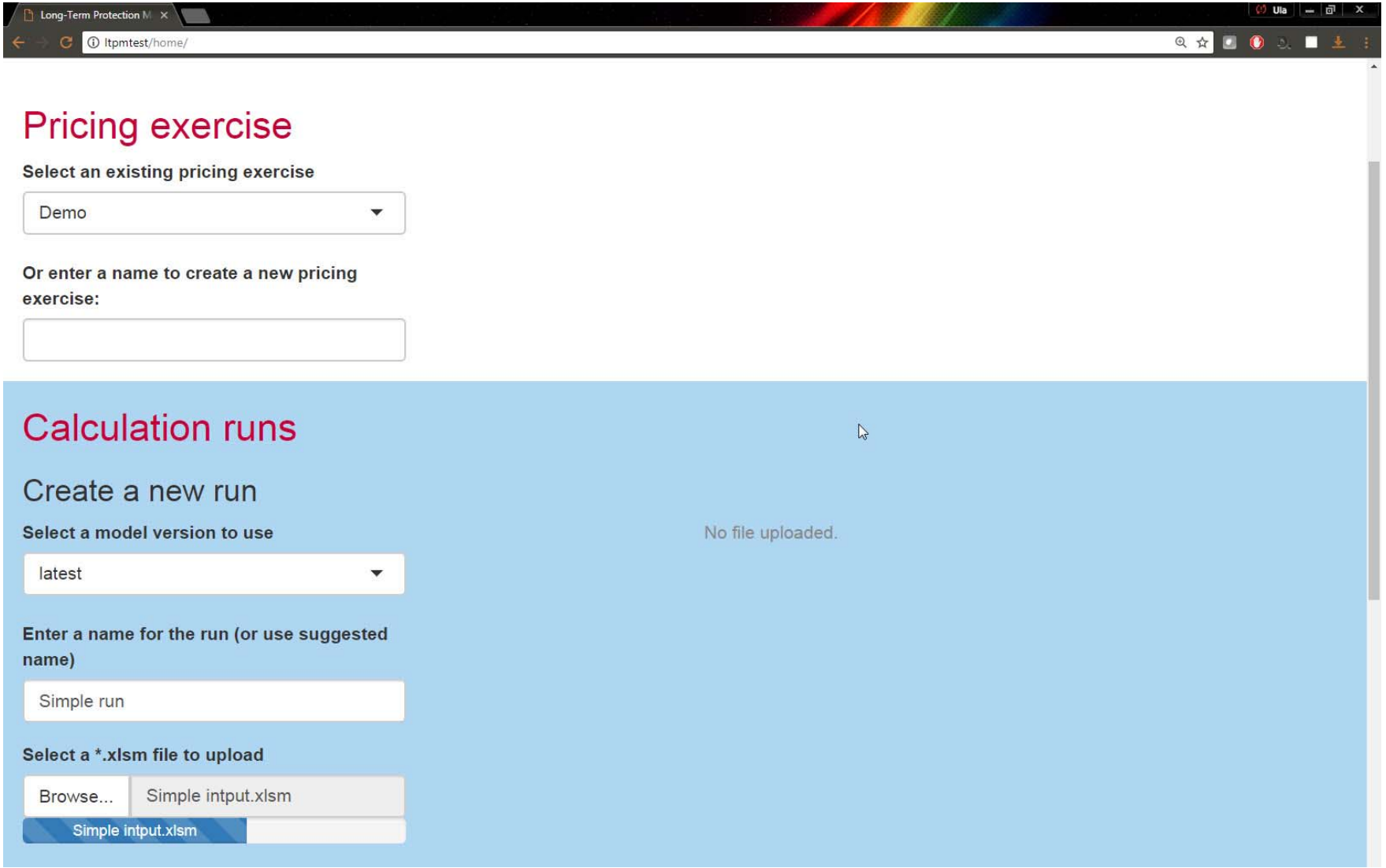


The interface


Long-Term Protection M
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Pricing exercise
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Demo
Or enter a name to create a new pricing exercise:
Calculation runs
Create a new run
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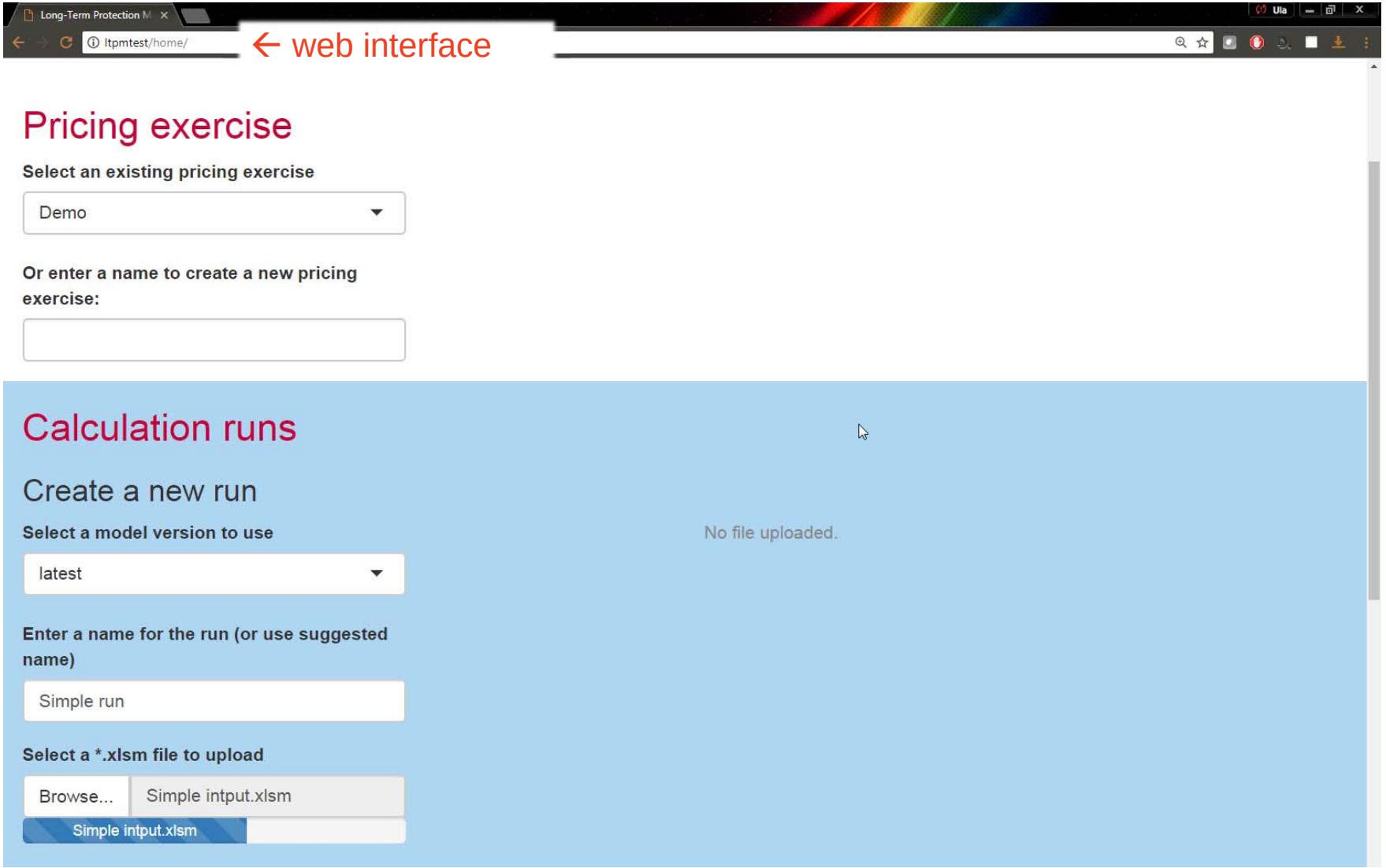
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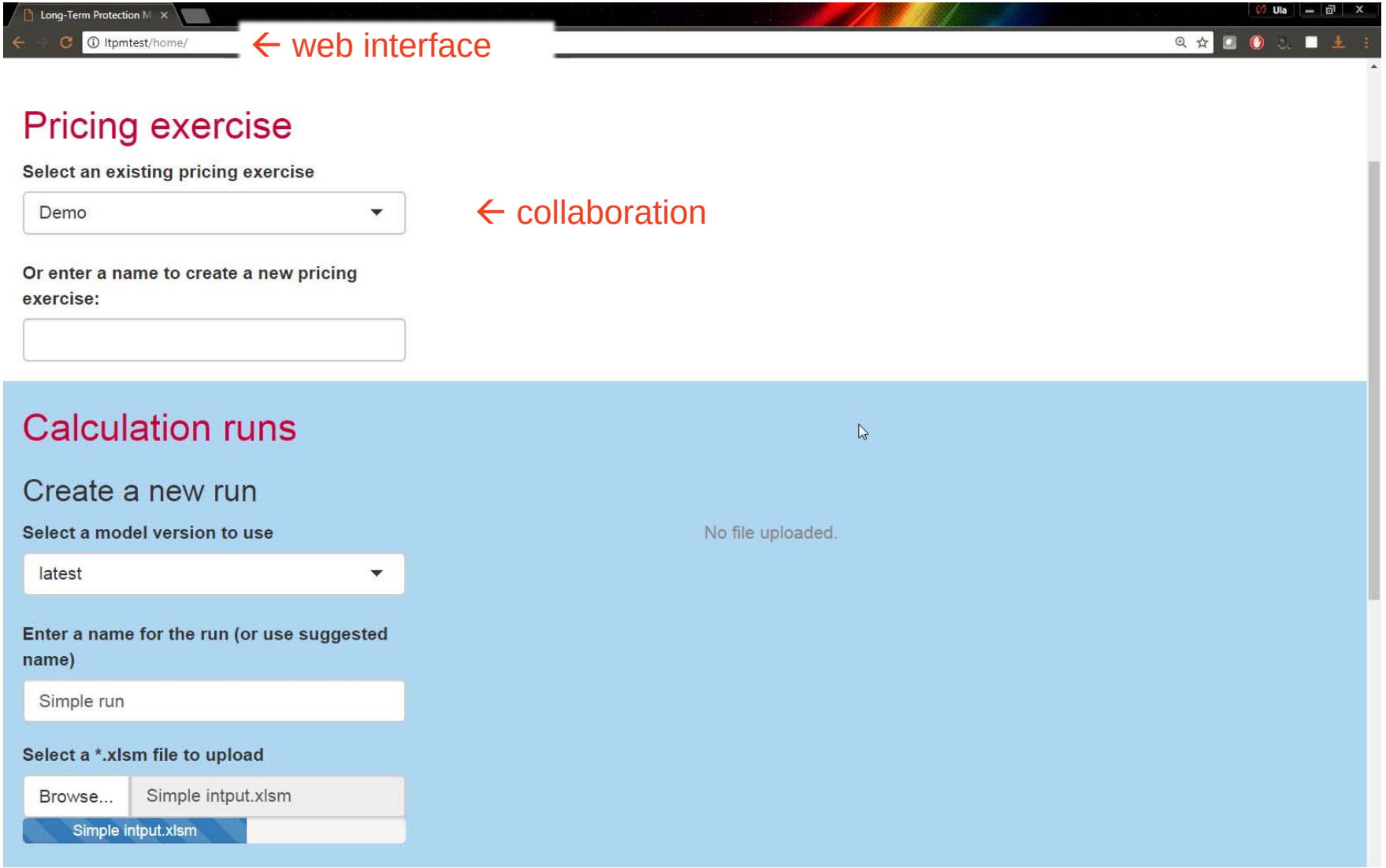
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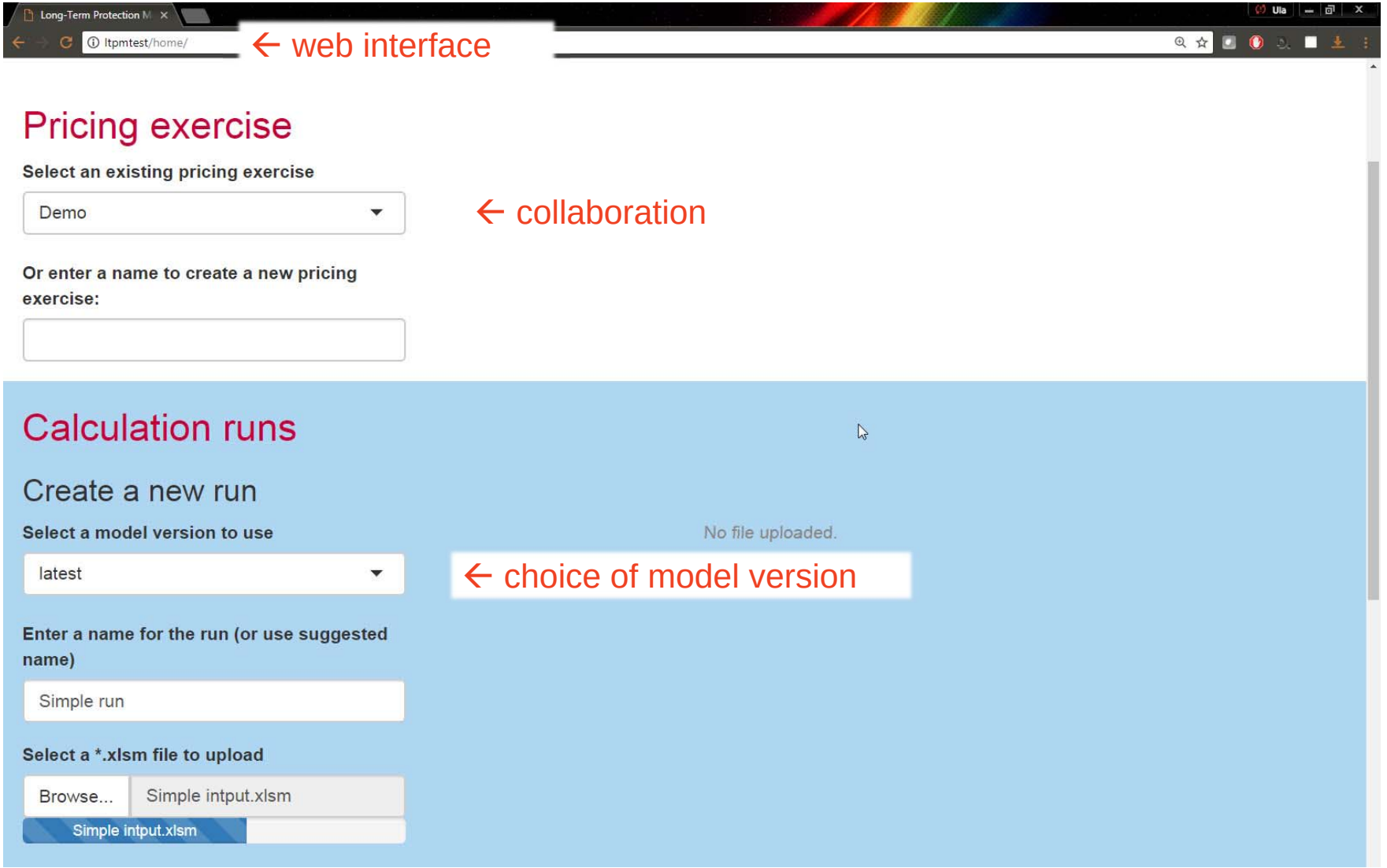
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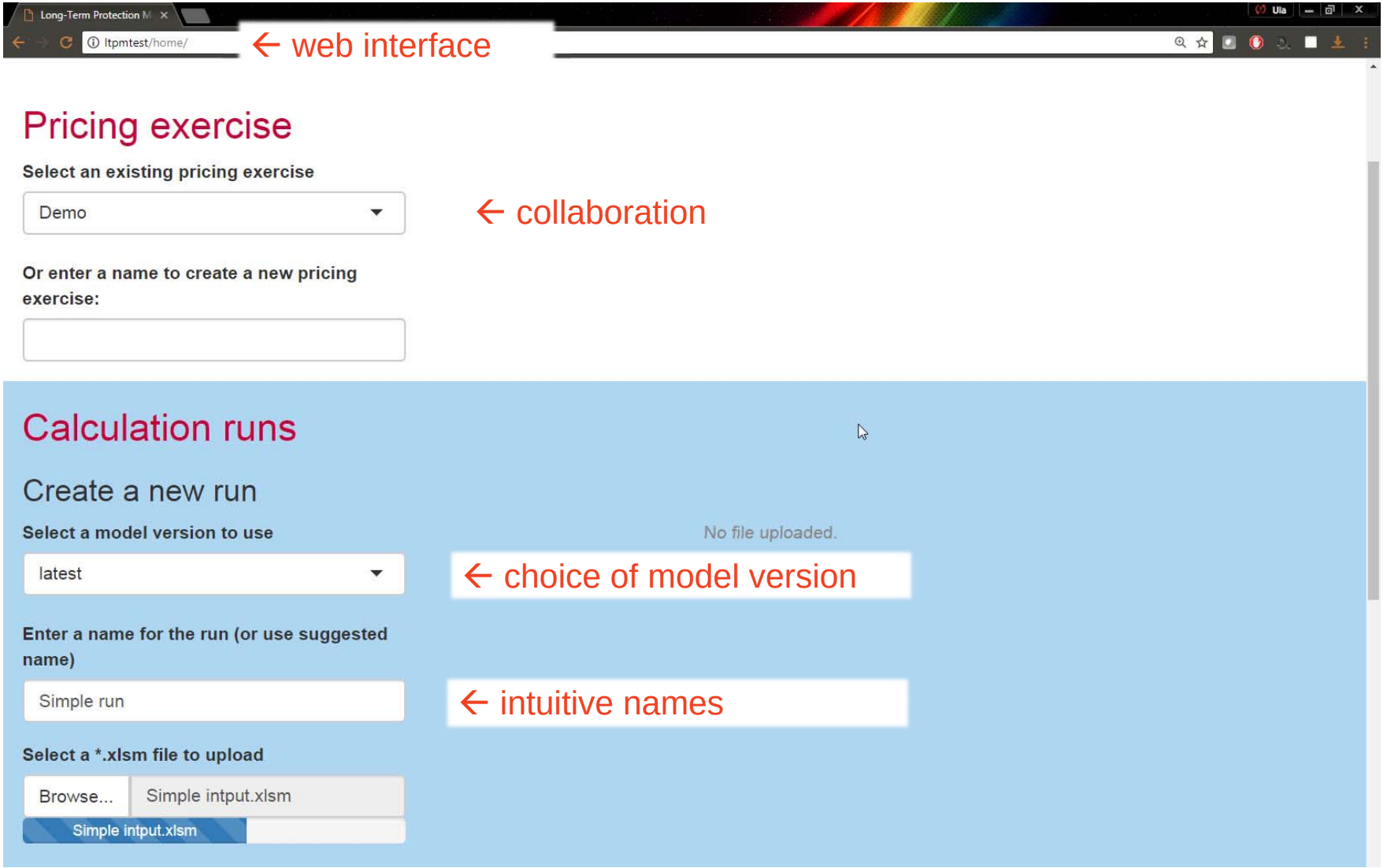
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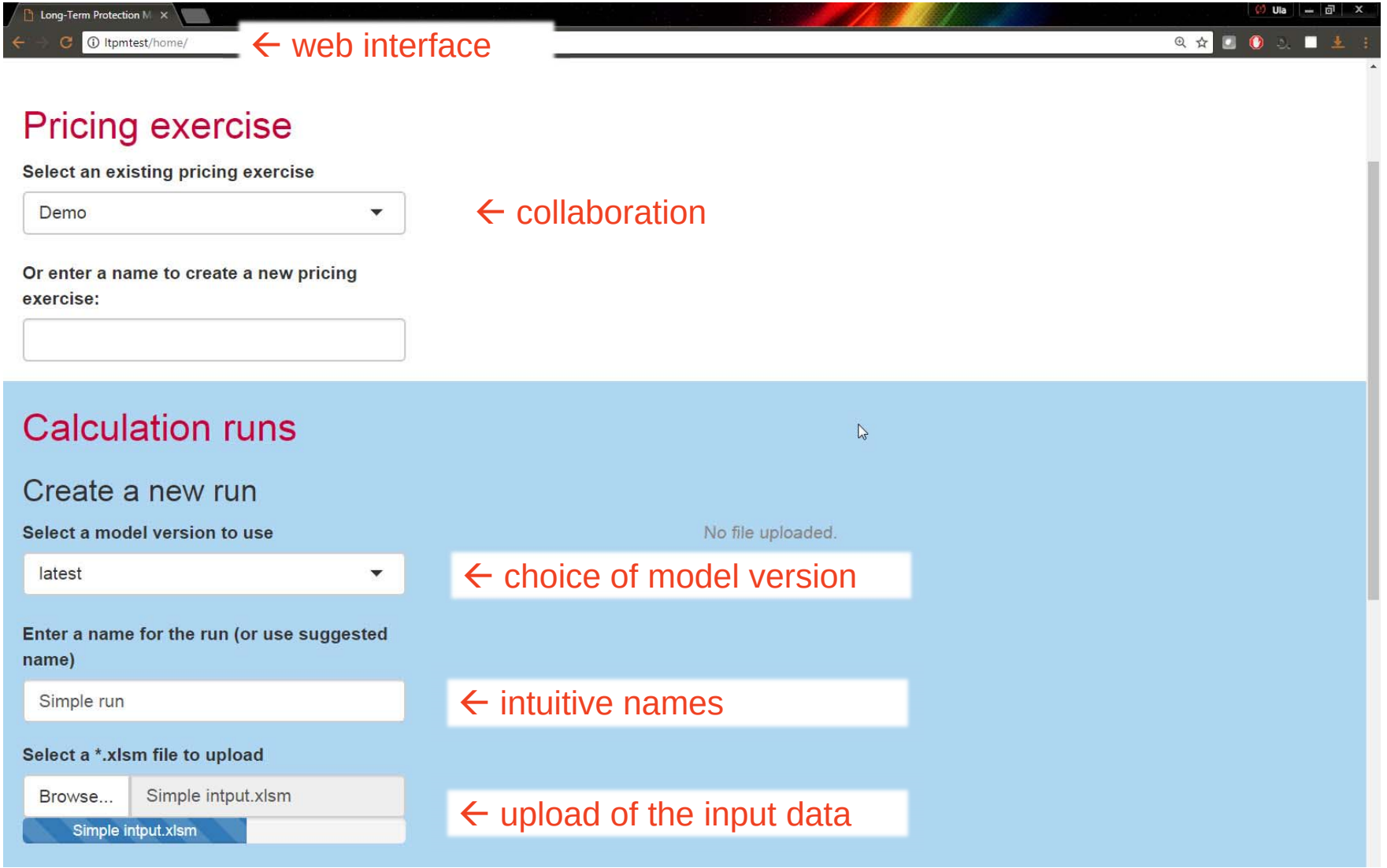
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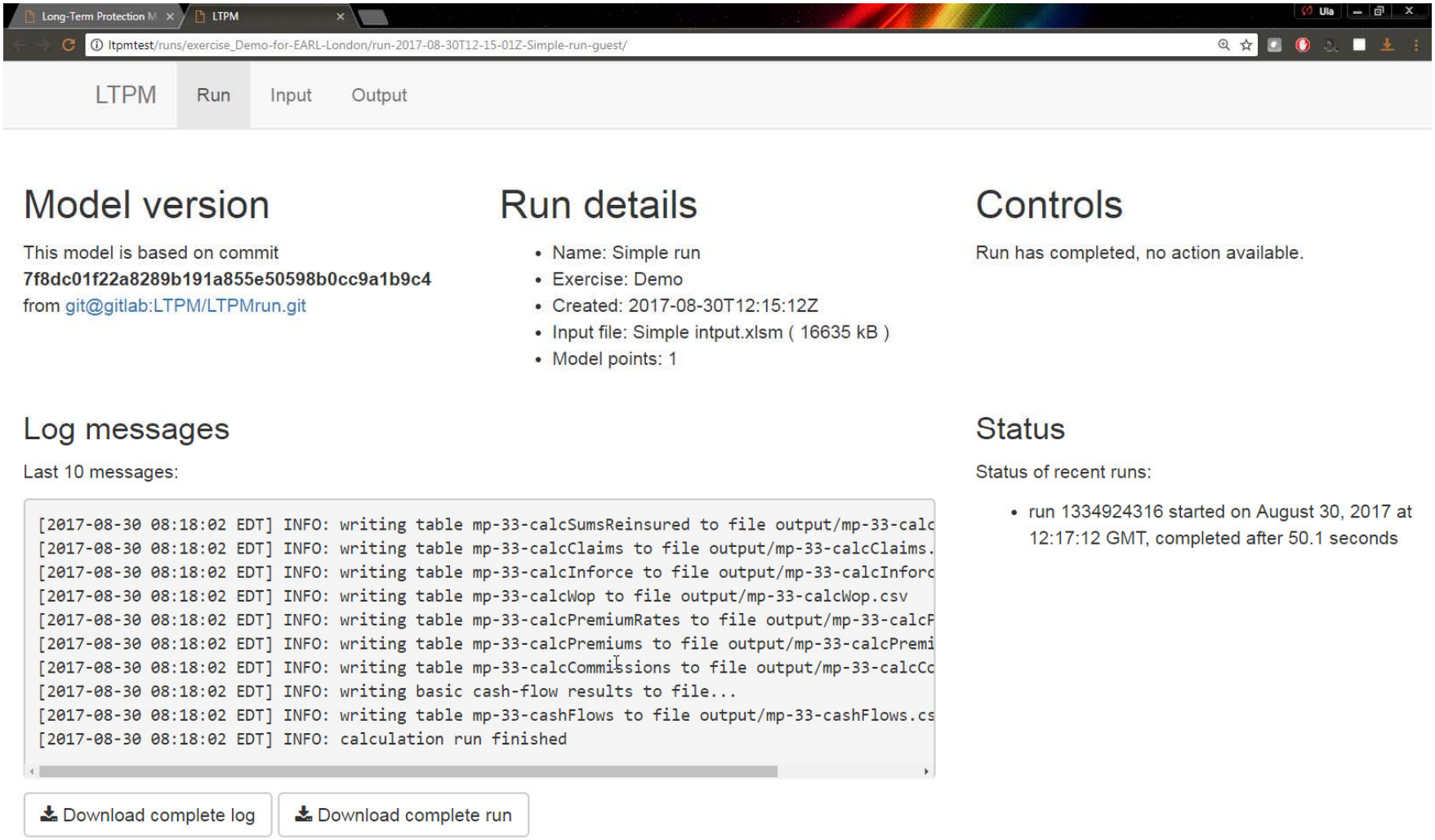
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LTPM
ltpmtest/runs/exercise_Demo-for-EARL-London/run-2017-08-30T12-15-01Z-Simple-run-guest/
LTPM
Run
Input
Output
Model version
This model is based on commit
7f8dc01f22a8289b191a855e50598b0cc9a1b9c4
from git@gitlab:LTPM/LTPMrun.git
Run details
Name: Simple run
Exercise: Demo
Created: 2017-08-30T12:15:12Z
Input file: Simple intput.xlsm (16635 kB)
Model points: 1
Controls
Run has completed, no action available.
Log messages
Last 10 messages:
[2017-08-30 08:18:02 EDT] INFO: writing table mp-33-calcSumsReinsured to file output/mp-33-calc
[2017-08-30 08:18:02 EDT] INFO: writing table mp-33-calcClaims to file output/mp-33-calcClaims.
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[2017-08-30 08:18:02 EDT] INFO: calculation run finished
Download complete log
Download complete run
Status
Status of recent runs:
run 1334924316 started on August 30, 2017 at 12:17:12 GMT, completed after 50.1 seconds

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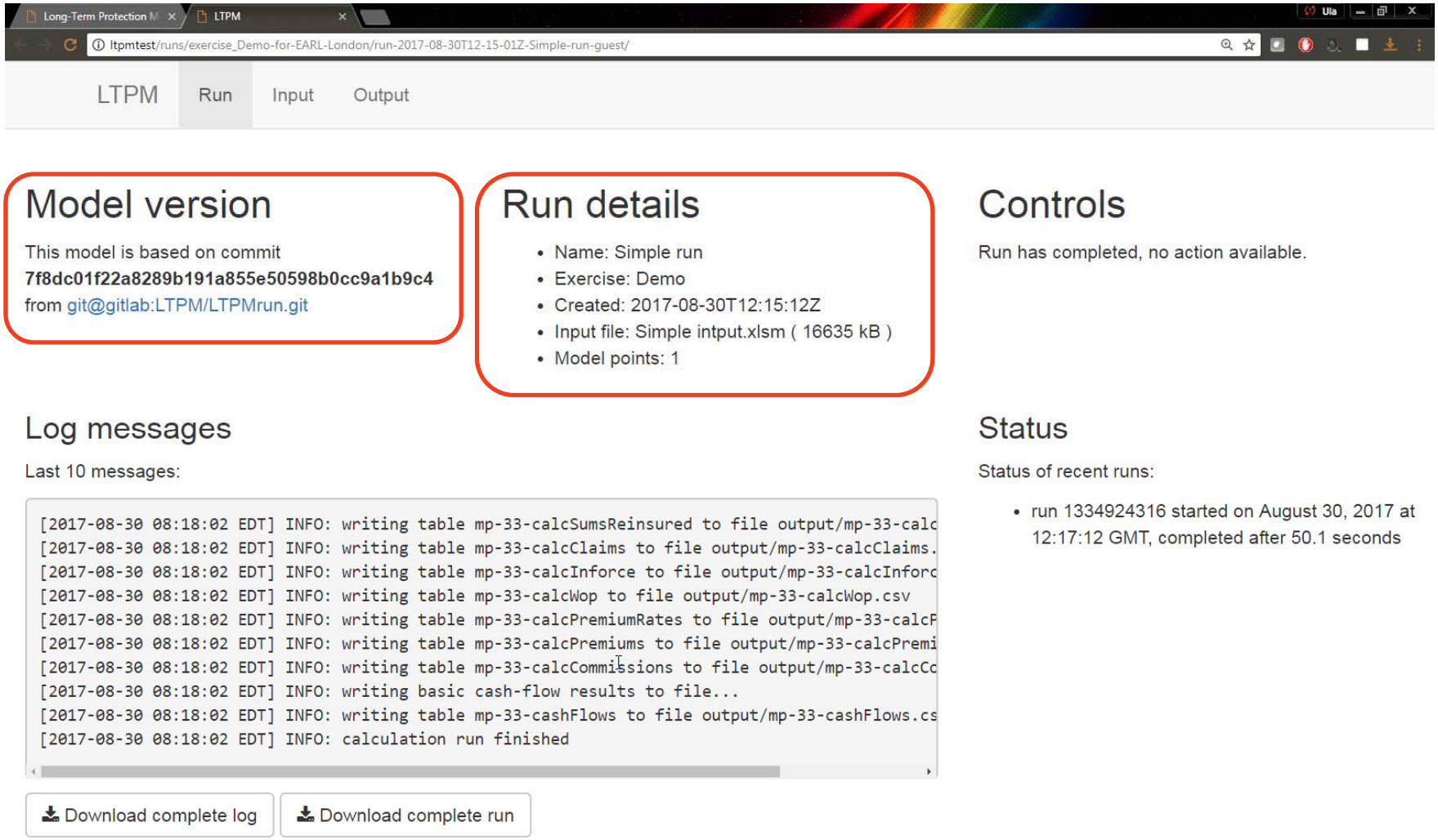
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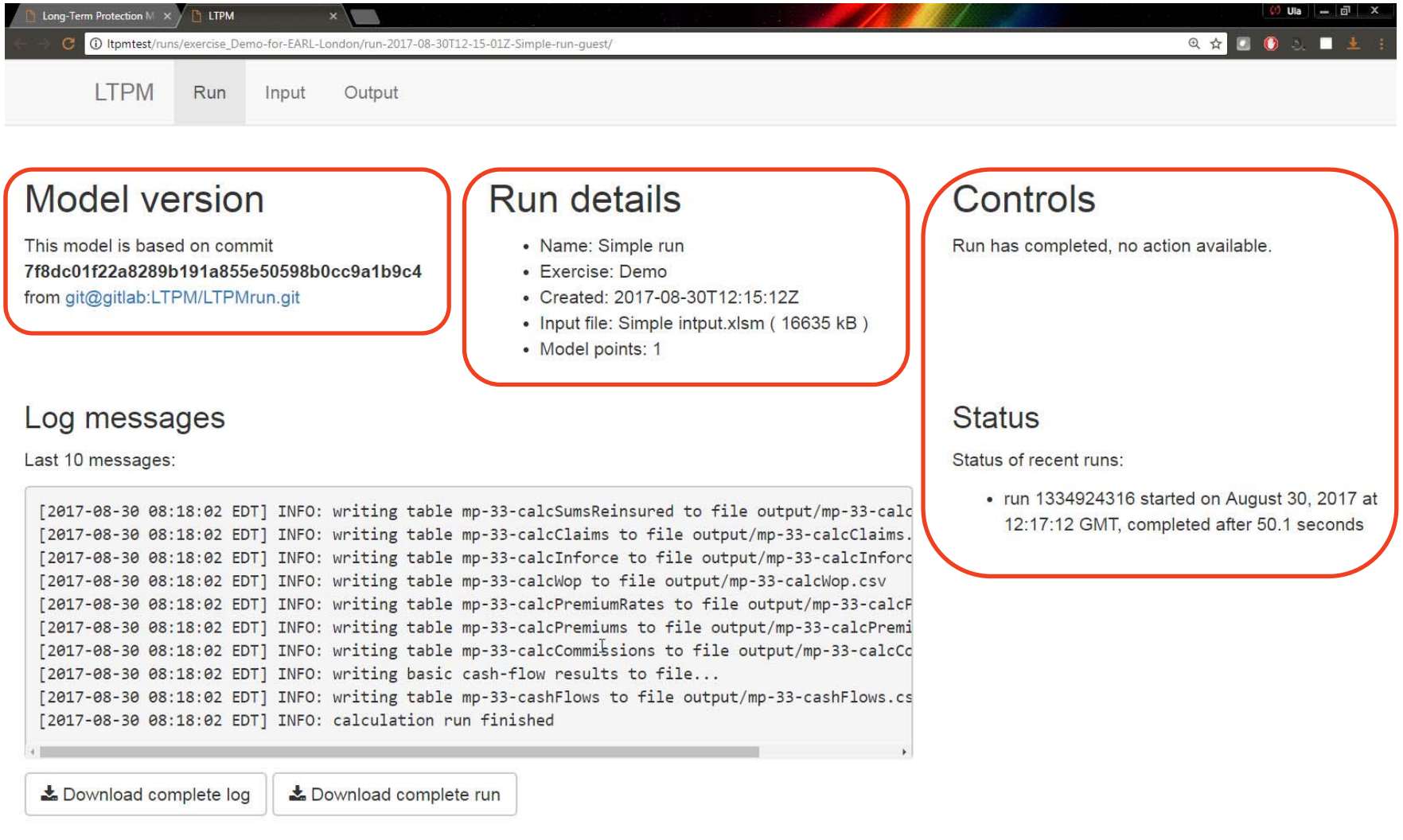
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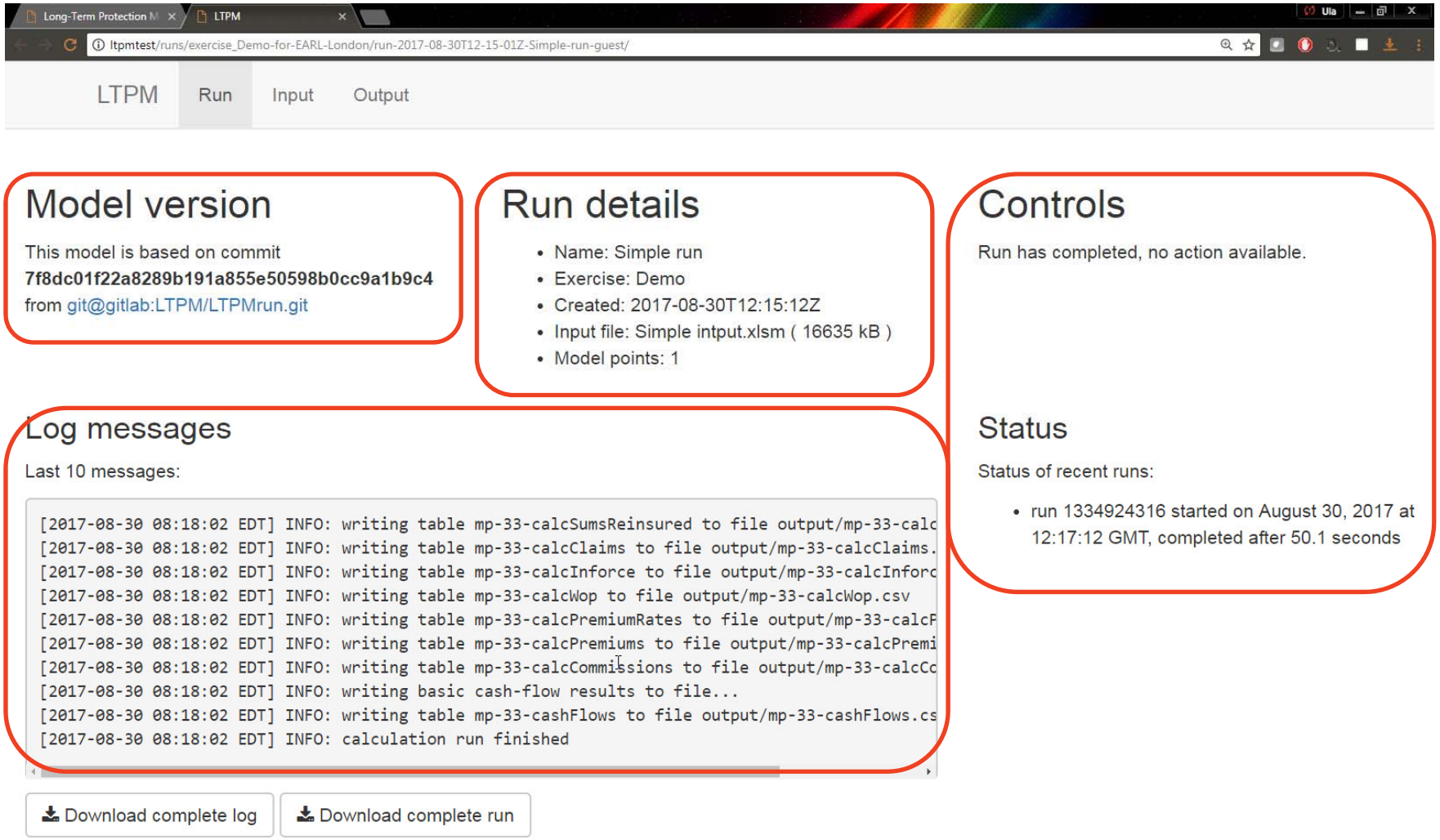
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Download complete run

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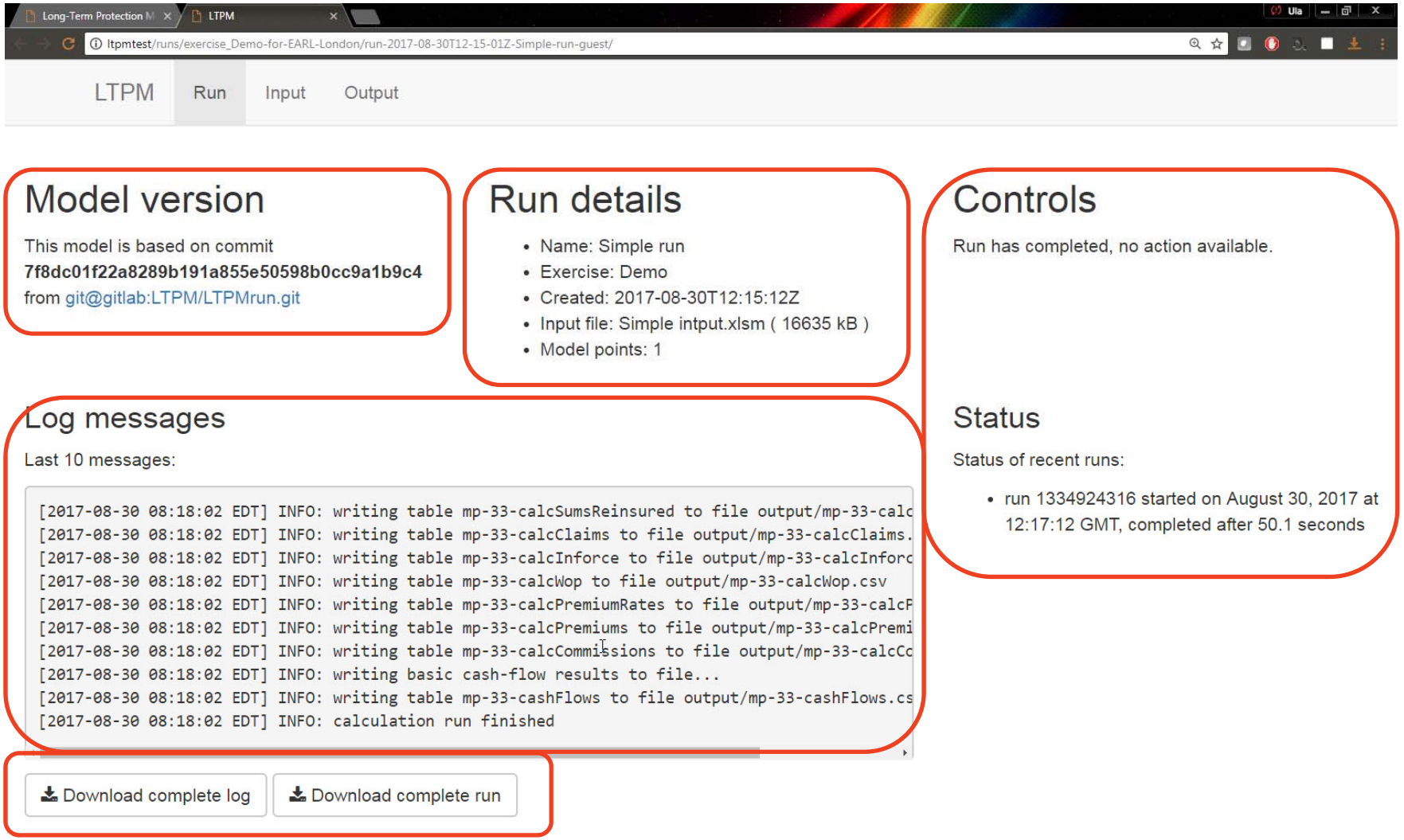
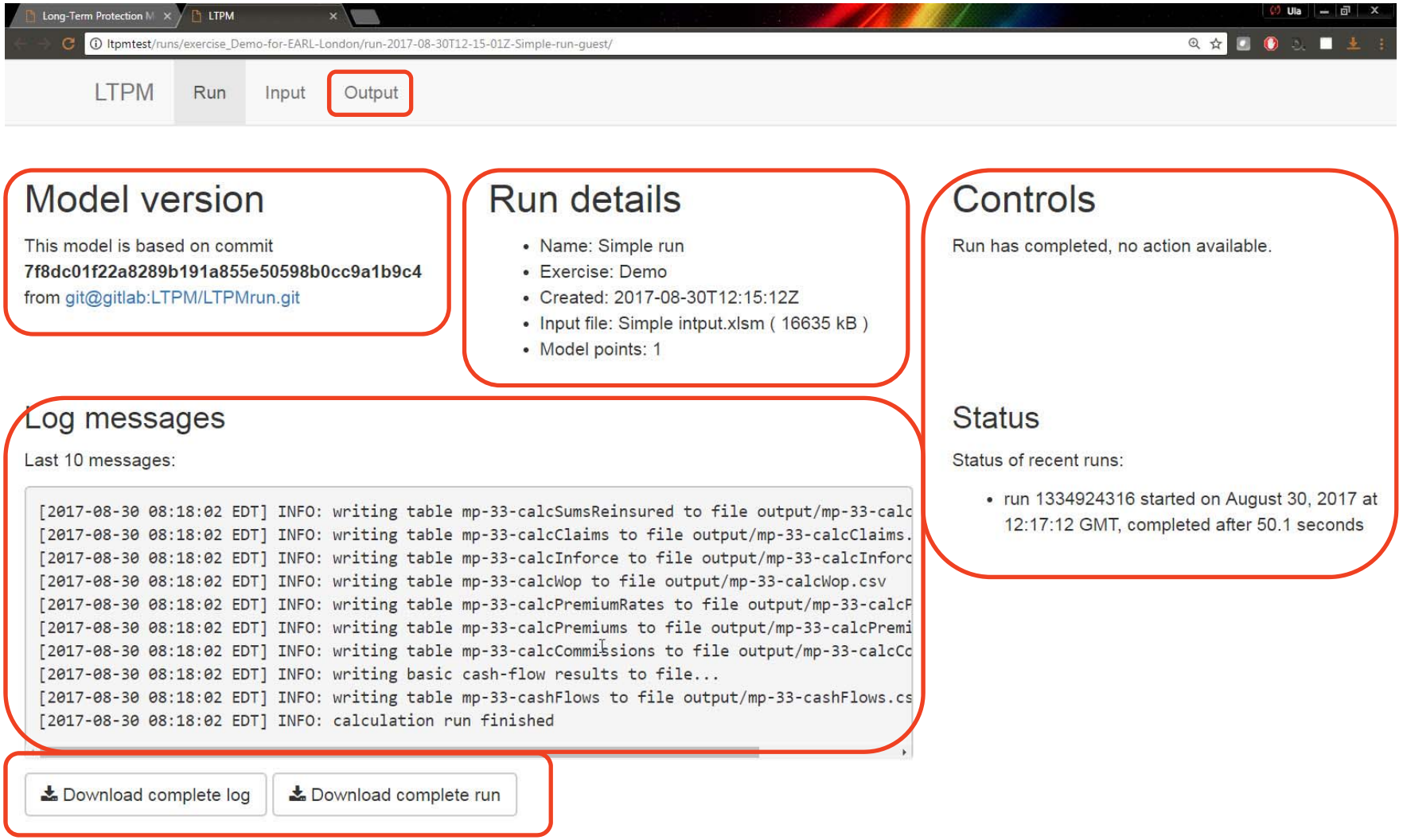

Long-Term Protection M
LTPM
ltpmtest/runs/exercise_Demo-for-EARL-London/run-2017-08-30T12-15-01Z-Simple-run-guest/
LTPM
Run
Input
Output
Model version
This model is based on commit
7f8dc01f22a8289b191a855e50598b0cc9a1b9c4
from git@gitlab:LTPM/LTPMrun.git
Run details
Name: Simple run
Exercise: Demo
Created: 2017-08-30T12:15:12Z
Input file: Simple intput.xlsm (16635 kB)
Model points: 1
Controls
Run has completed, no action available.
Log messages
Last 10 messages:
[2017-08-30 08:18:02 EDT] INFO: writing table mp-33-calcSumsReinsured to file output/mp-33-calc
[2017-08-30 08:18:02 EDT] INFO: writing table mp-33-calcClaims to file output/mp-33-calcClaims.
[2017-08-30 08:18:02 EDT] INFO: writing table mp-33-calcInforce to file output/mp-33-calcInforc
[2017-08-30 08:18:02 EDT] INFO: writing table mp-33-calcWop to file output/mp-33-calcWop.csv
[2017-08-30 08:18:02 EDT] INFO: writing table mp-33-calcPremiumRates to file output/mp-33-calcP
[2017-08-30 08:18:02 EDT] INFO: writing table mp-33-calcPremiums to file output/mp-33-calcPremi
[2017-08-30 08:18:02 EDT] INFO: writing table mp-33-calcCommissions to file output/mp-33-calcCo
[2017-08-30 08:18:02 EDT] INFO: writing basic cash-flow results to file...
[2017-08-30 08:18:02 EDT] INFO: writing table mp-33-cashFlows to file output/mp-33-cashFlows.cs
[2017-08-30 08:18:02 EDT] INFO: calculation run finished
Status
Status of recent runs:
run 1334924316 started on August 30, 2017 at 12:17:12 GMT, completed after 50.1 seconds
Download complete log
Download complete run

PartnerRe


Long-Term Protection M
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ltpmtest/runs/exercise_Demo-for-EARL-London/run-2017-08-30T12-15-01Z-Simple-run-guest/
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[2017-08-30 08:18:02 EDT] INFO: writing table mp-33-calcPremiumRates to file output/mp-33-calcP
[2017-08-30 08:18:02 EDT] INFO: writing table mp-33-calcPremiums to file output/mp-33-calcPremi
[2017-08-30 08:18:02 EDT] INFO: writing table mp-33-calcCommissions to file output/mp-33-calcCc
[2017-08-30 08:18:02 EDT] INFO: writing basic cash-flow results to file...
[2017-08-30 08:18:02 EDT] INFO: writing table mp-33-cashFlows to file output/mp-33-cashFlows.cs
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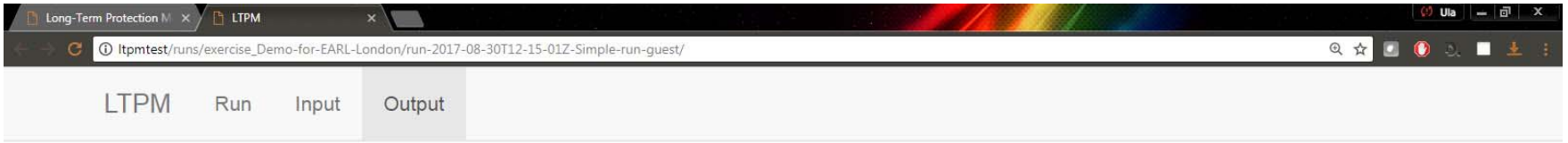
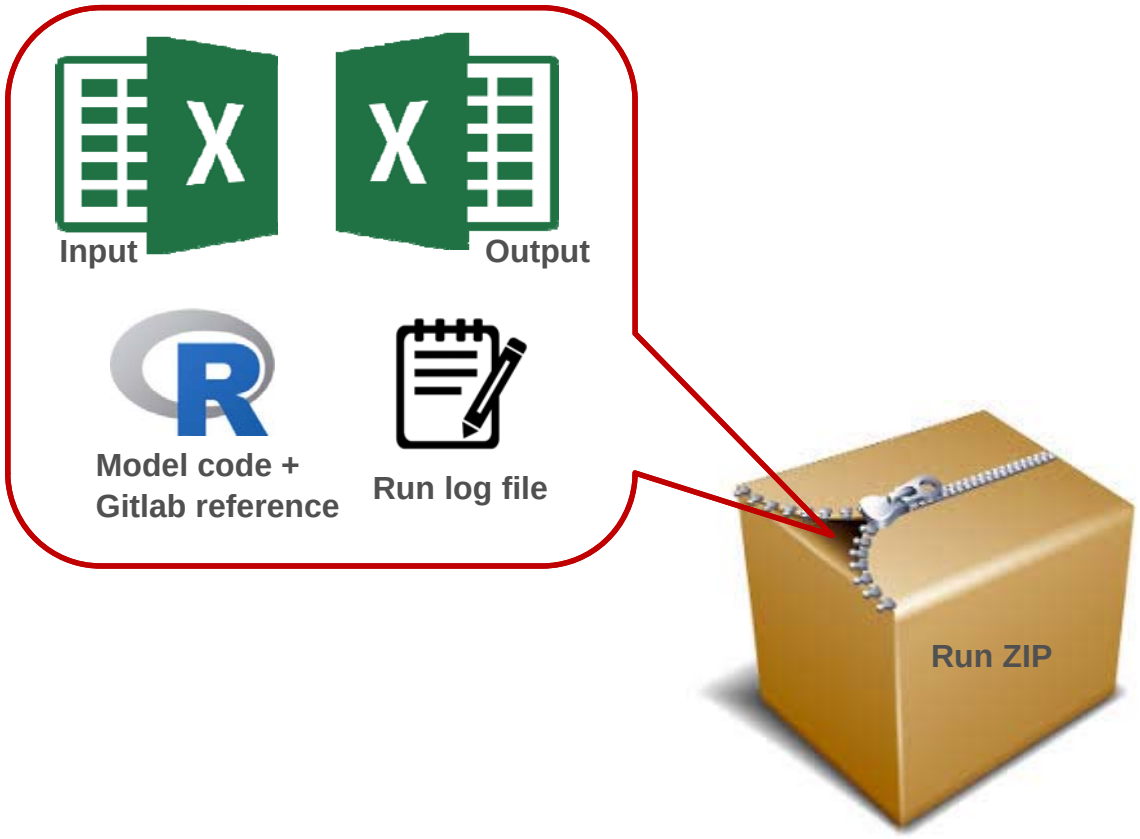
PartnerRe



Generated output

- mp-33-calcClaims.csv [download]
- mp-33-calcCommissions.csv [download]
- mp-33-calcIncidenceDeath.csv [download]
- mp-33-calcIncidenceLb1.csv [download]
- mp-33-calcInforce.csv [download]
- mp-33-calcPostIncidenceDeathFromLb1.csv [download]
- mp-33-calcPremiumRates.csv [download]
- mp-33-calcPremiums.csv [download]
- mp-33-calcSumsAssured.csv [download]
- mp-33-calcSumsReinsured.csv [download]
- mp-33-calcWop.csv [download]
- mp-33-cashFlows.csv [download]
- mp-33-getBaseIncidenceRateDeath.csv [download]
- mp-33-getBaseIncidenceRateLb1.csv [download]
- mp-33-getIncidenceImprovFactorDeath.csv [download]
- mp-33-getIncidenceImprovFactorLb1.csv [download]
- mp-33-getLapseRateFromHealthy.csv [download]
- mp-33-getLapseRateFromLb1.csv [download]

Content of a run



The anatomy

GitLab

GitLab repository

LTPM

PartnerRe

Shiny applications

There are two Shiny applications in the LTPM:

1. **LTPMcreate**: the main application where pricing exercises can be defined and runs can be created.
2. **LTPMrun**: an interface to each individual run which displays run details (e.g. input files and settings), status messages, and provides access to results.

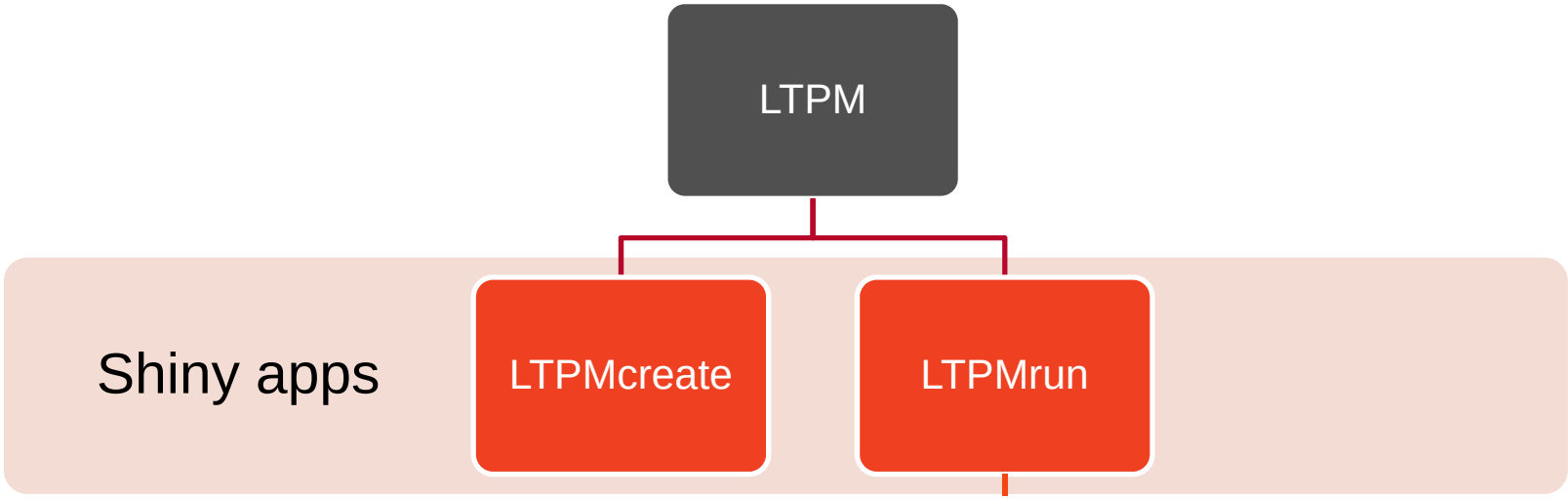
GitLab

GitLab repository

LTPM

GitLab

GitLab repository



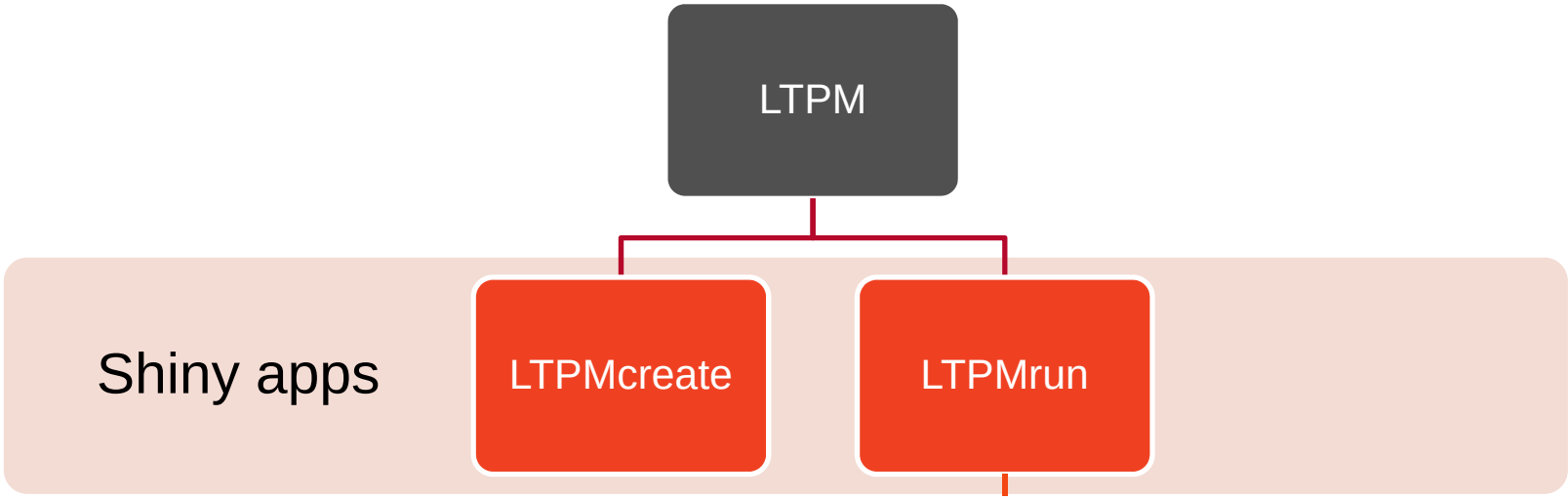
R packages

To support the calculations we have created three R extension packages:

1. **LTPMcalc**: includes all functionality for the actual calculations for the multi-state model.
2. **LTPMinput**: functionality to convert user input (i.e. spreadsheets) to an intermediate format (i.e. CSV).
3. **LTPMlogging**: functionality to allow all scripts and applications to log time-stamped information to the console or to a file on disk.

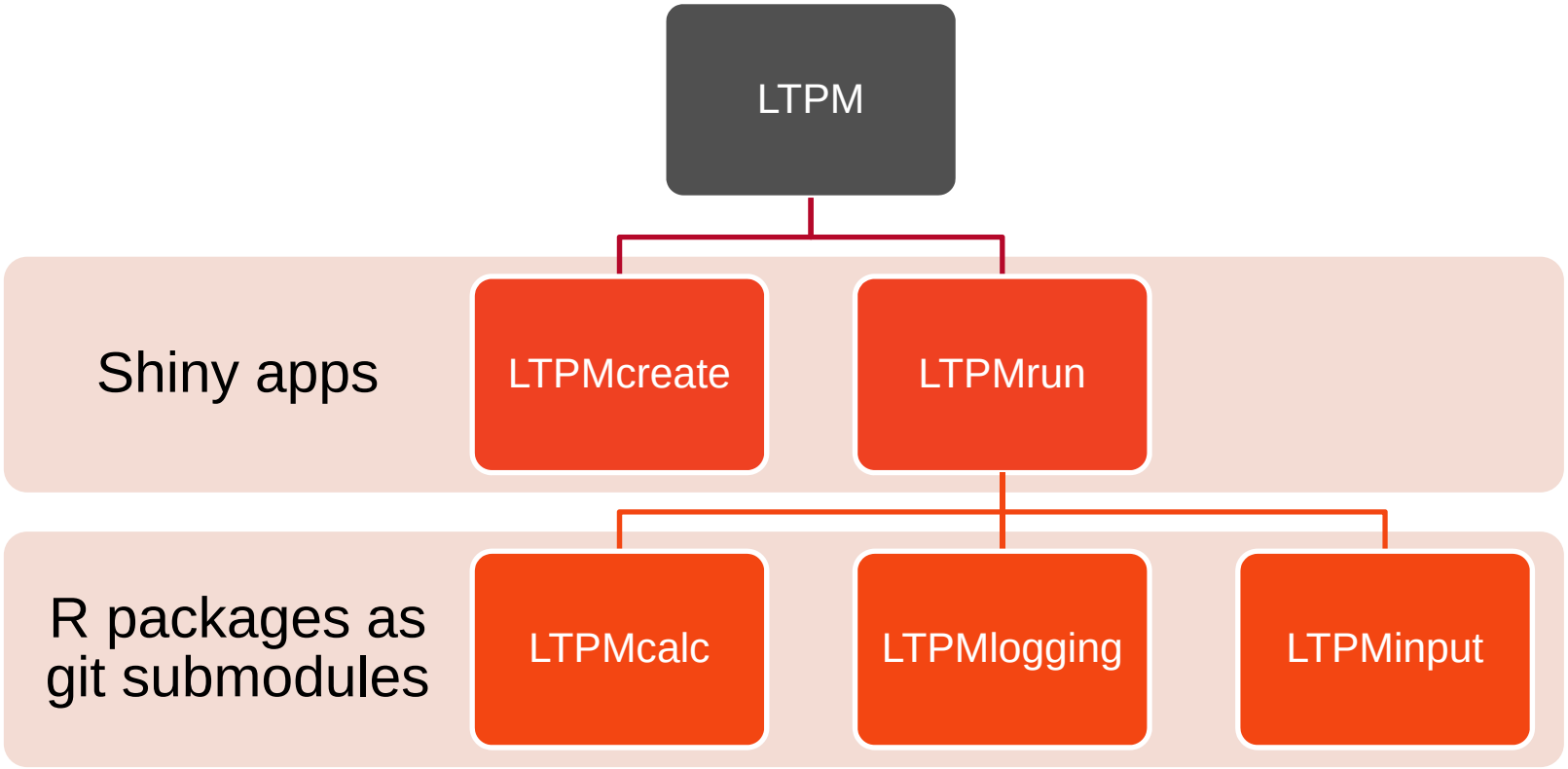
GitLab

GitLab repository



GitLab

GitLab repository

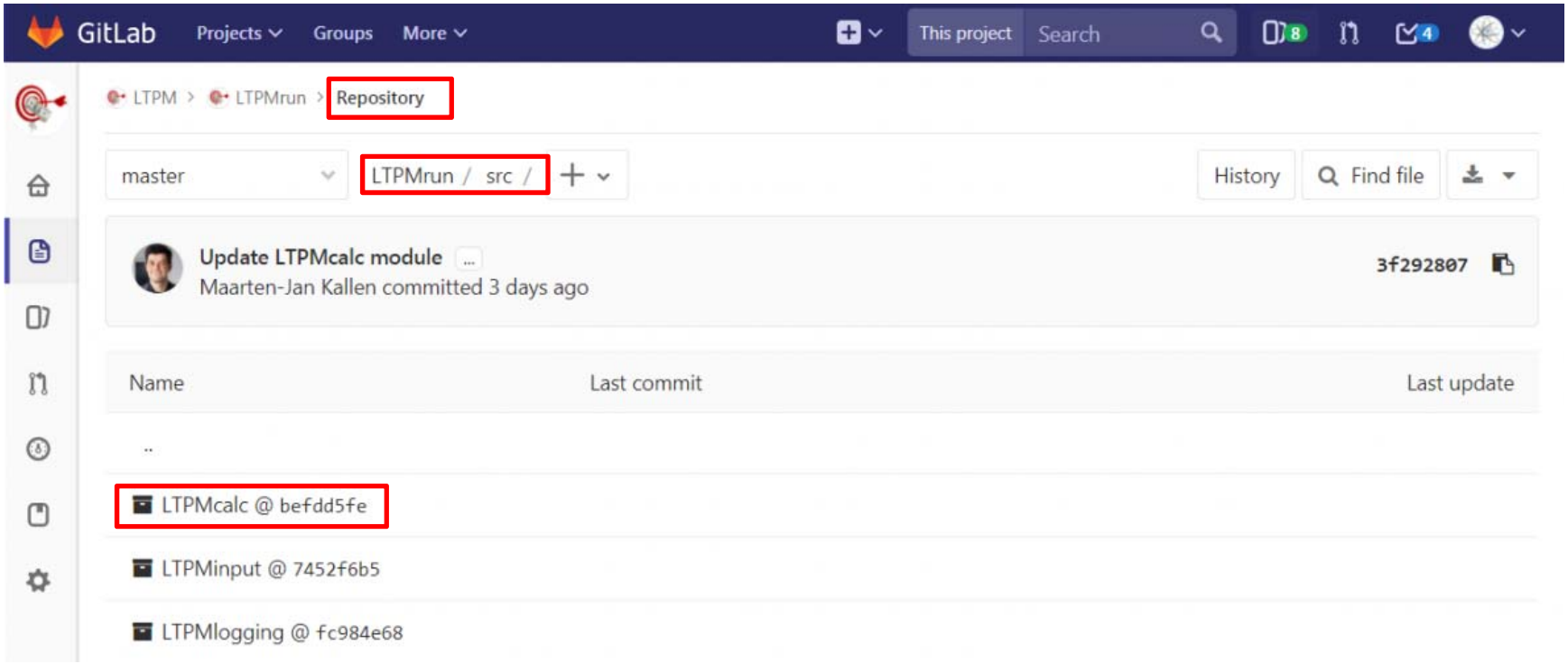


GitLab group

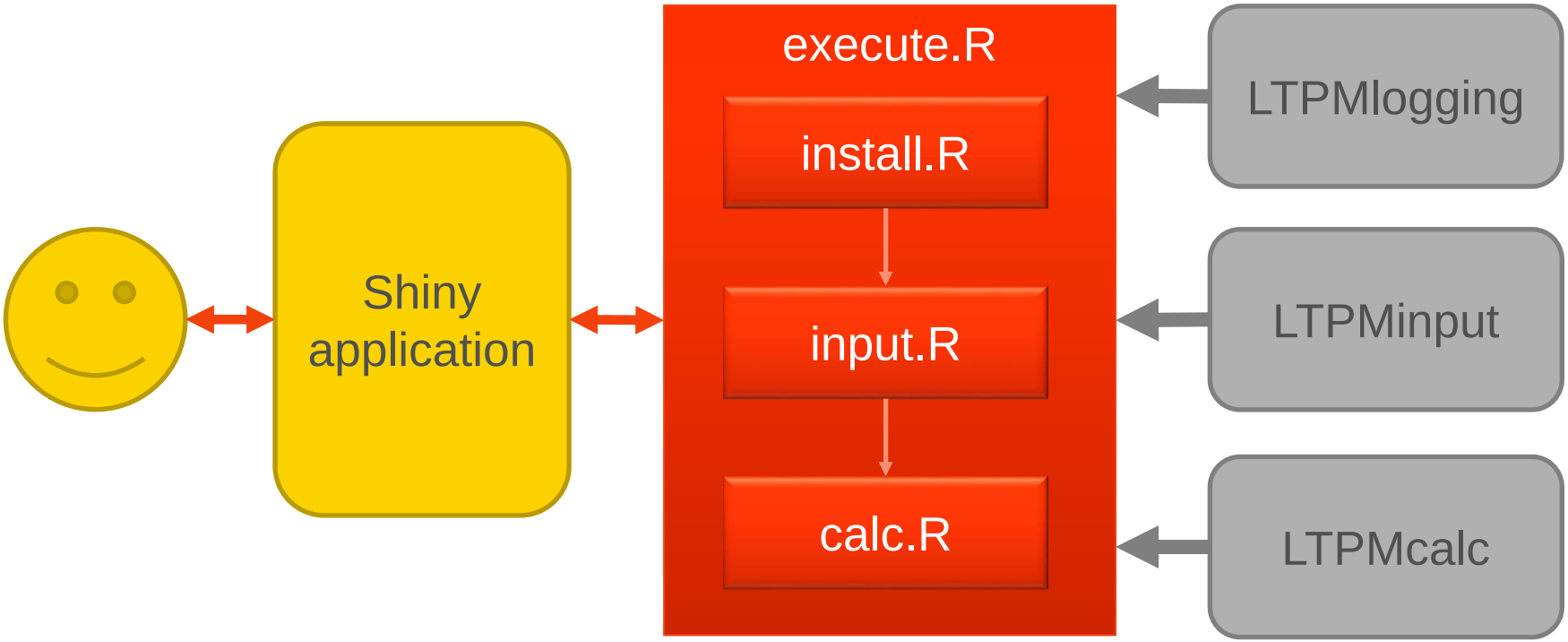
GitLab project

PartnerRe

Packages as git submodules – GitLab view



Anatomy of LTPMrun



Executable R scripts

The *LTPMrun* application has one R script to execute a full calculation run called **execute.R**.

This script defines three execution steps, each implemented in a separate R script:

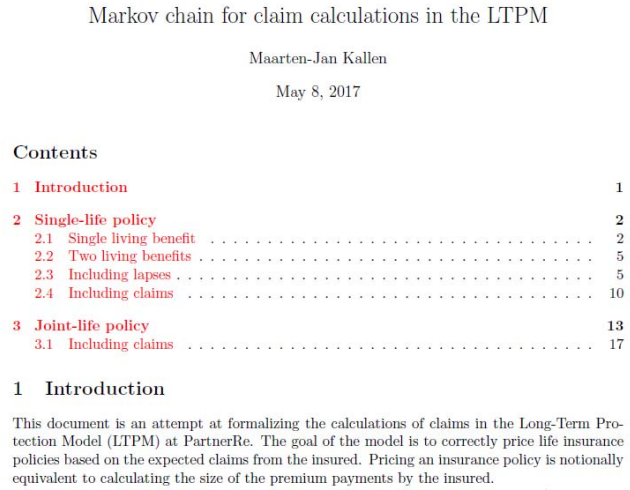
1. **install.R**: installation of R extension packages required by the run,
2. **input.R**: reading and conversion of input file(s) provided by the user,
3. **calc.R**: perform the calculations.

LTPMcalc

The R package which implements the actual model functionality including the multi-state model.

The multi-state model is a Markov chain, which is a discrete-time Markov process.

Implementation details can be found in the package ‘vignette’.



Markov chain for claim calculations in the LTPM

Maarten-Jan Kallen

May 8, 2017

Contents

1 Introduction

This document is an attempt at formalizing the calculations of claims in the Long-Term Protection Model (LTPM) at PartnerRe. The goal of the model is to correctly price life insurance policies based on the expected claims from the insured. Pricing an insurance policy is notionally equivalent to calculating the size of the premium payments by the insured.

PartnerRe

Flexibility and adaptability

GitLab

Choice of actuarial model version

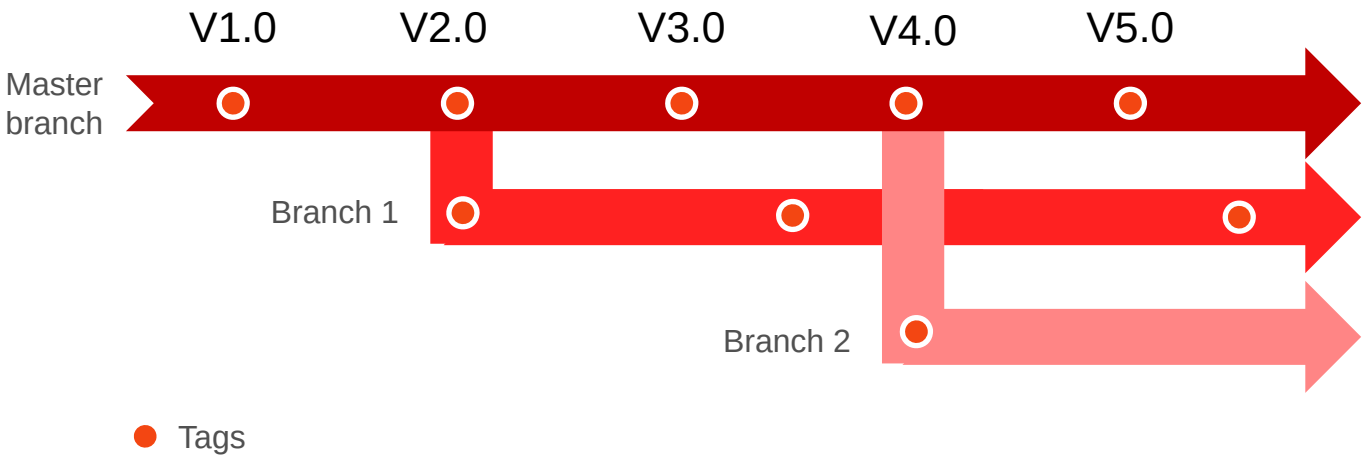
User can choose between:

- the latest released version

- past released versions

- customized version created by themselves

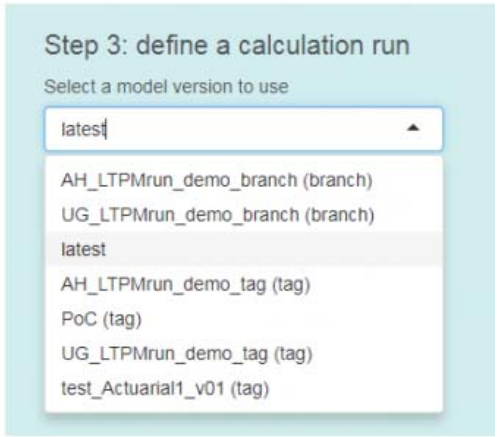
- customized version created by other user



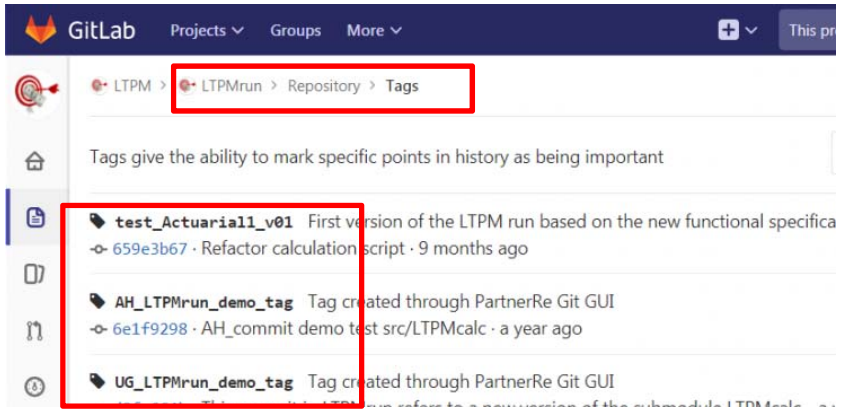
PartnerRe

GitLab

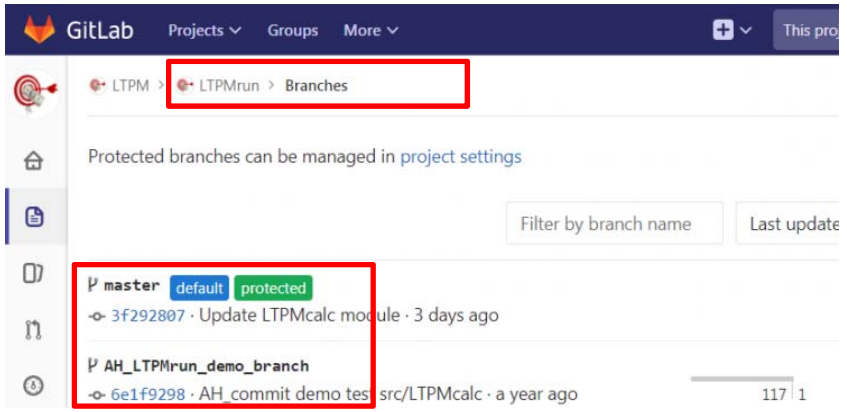
Choice of actuarial model version



list of git tags



list of git branches



Quality assurance

How do we ensure that the model is correct?

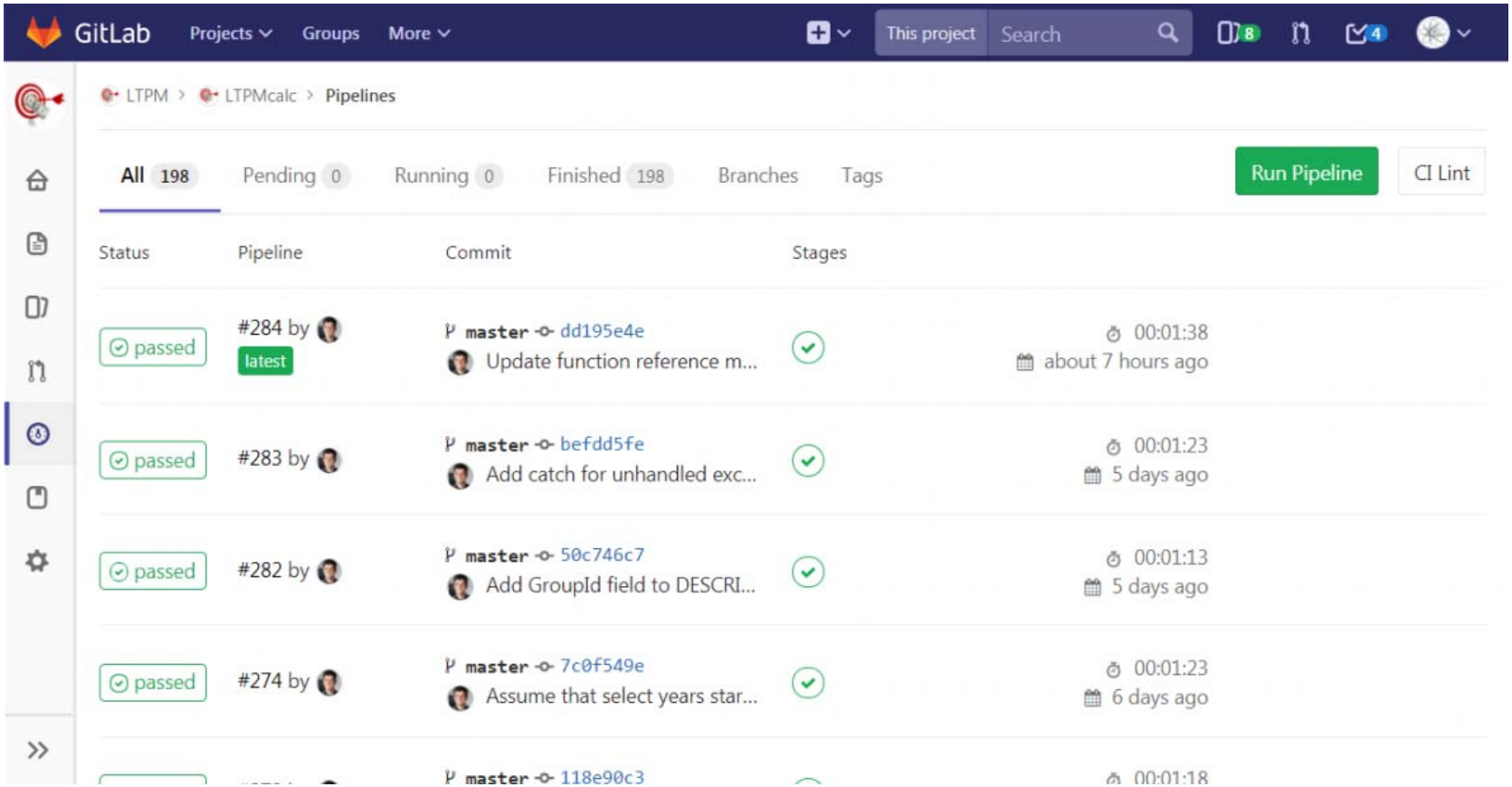
We can never guarantee that the model is completely free of errors and bugs. To minimize errors, we apply standard practices for quality assurance in software development:

1. Many small unit tests for individual functions.
2. Integration (i.e. end-to-end) tests using pre-calculated results.
3. User testing.

GitLab

- **Source code version control using Git.**
- **Issue tracker to track bugs and our progress in fixing these.**
- **Continuous Integration (CI) ‘pipelines’ to automatically test –on the target system– all changes committed to the source code repository.**
  - performed in target environment
  - immediate upon push
  - notifications can be send to Slack

GitLab - Continuous Integration



PartnerRe

Questions?