Making Health Economic Models Shiny: Our experience helping companies transition from Excel to R & shiny

R Consortium 2025 | 18th November 2025

rsmith@darkpeakanalytics.com

https://github.com/dark-peak-analytics

https://www.linkedin.com/company/dark-peak-analytics

Introduction

Dr Robert Smith

Director, Dark Peak Analytics

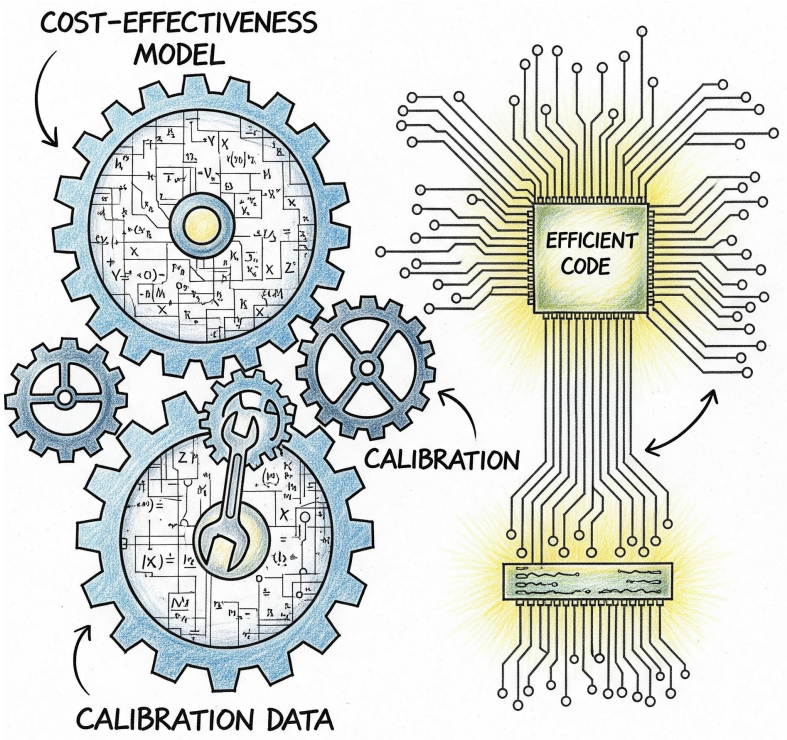
PhD Public Health Economics & Decision Science
UKHSA during pandemic (2020 - 2022)
Director of R-4-HTA consortium

Introduction

Dr Wael Mohammed

Principal Health Economist, Dark Peak Analytics

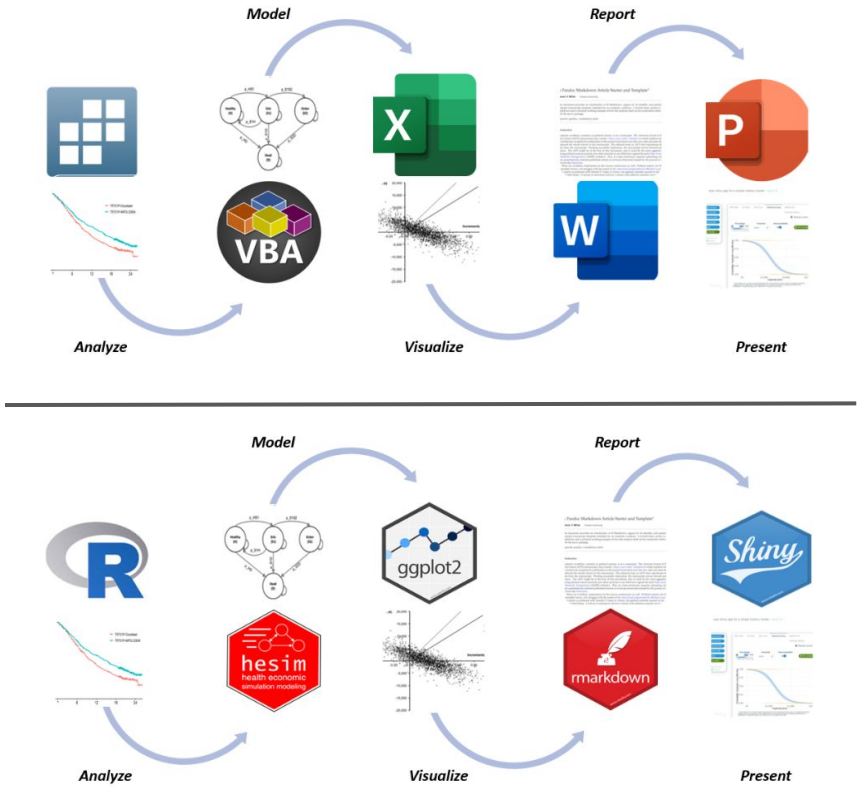
PhD Public Health Economics & Decision Science
University of Sheffield (2025)
University of Newcastle (2019)



Background

Overarching aim

Shift the health economic modelling pipeline from spreadsheet software (e.g. MS Excel) to script based programming languages (e.g R).

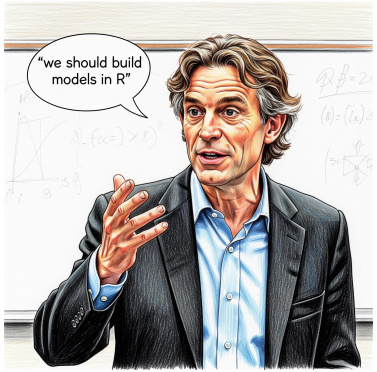


Spreadsheets vs R (python / others)

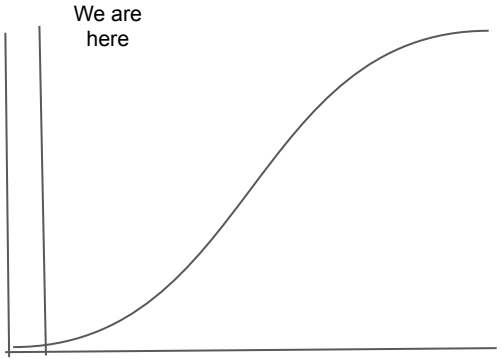
				Comments
1	Capabilities	●●	●●●●●	R is more flexible
2	Engagement & Visualisation	●●●	●●●●	... looks better
3	Computational Speed	●	●●●●	... faster
4	Development & Iteration speed	●●	●●●●	... easier to scale
5	Transparency	●●	●●●●●	... more transparent
6	Familiarity Barriers to entry	●●●●	●	But coding in R is hard

An entirely personal, and very biased set of estimates!

History



pre-2020

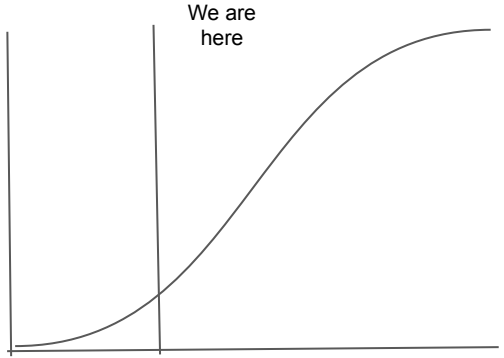


Publications

Training

Adoption

2020-2023

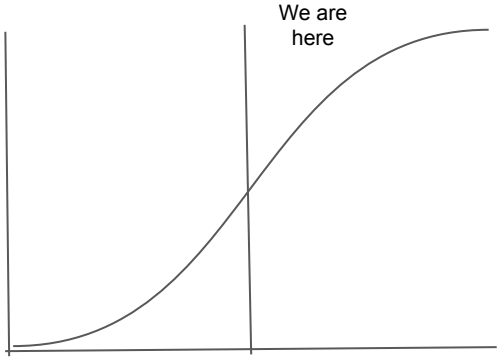


Publications

Training

Adoption

2024-2025



Publications

Training

Adoption

Timeline

Flexsurv published
This package was published in the Journal of Statistical Software.

R for HTA Consortium founded
The consortium was established to accelerate the adoption of R for health technology assessment.

Making HE Models Shiny
Demonstrates how to make models more usable with web-based UIs.

DCEA App published
Hosted by the University of York, and used by non-programmers to estimate distributional effects of policies.

R consortium launches working group
Multiple R submissions
Early engagement by Industry & consulting with workstreams planned for package validation.

2016 2017 2018 2019 2020 2021 2022 2023 2024 2025

Heemod published

Designed for writing Markov models for health economic evaluations.

DARTH group teaches at SMDM

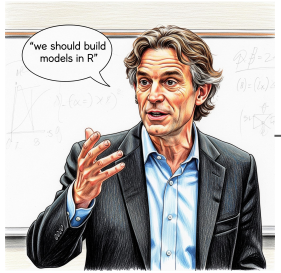
The group begins teaching "Survival Analysis and Decision Modeling Using R" at the SMDM meeting.

QALY Shortfall tool available

This tool is a web-based Shiny application that provides estimates for QALY shortfall.

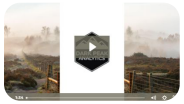
NICE Pilots RCC Pathways R model
The pilot was for Renal Cell Carcinoma and later moved into a Technology Appraisal.

R for HTA book published
Multiple R submissions
The R for HTA book was published in 2025 to further accelerate the adoption of R for health technology assessment.



Timeline - our small role.

Now an **un**popular course

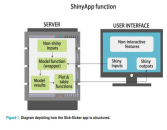


Now on CRAN

2021 2022 2023 2024 2025

Making Health Economic Models Shiny: A tutorial

Smith & **Schneider.** Making health economic models Shiny: A tutorial. *Wellcome Open Res* 2020, **5**:69 (https://doi.org/10.12688/wellcomeopenres.15807.2)

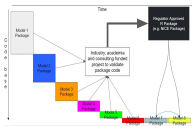


Living HTA: Automating Health Economic Evaluation with R

Smith, Schneider and **Mohammed**. Living HTA: Automating Health Economic Evaluation with R. *Wellcome Open Res* 2022, **7**:194 (https://doi.org/10.12688/wellcomeopenres.17933.2)

R Packages for health economic evaluation: A tutorial

Smith RA, Mohammed W and **Schneider PP**. R Packages for health economic evaluation: A tutorial. 2023. (https://wellcomeopenresearch.org/articles/8-419)



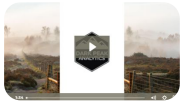
assertHE: an R package to improve quality assurance of health economic models

Smith, Samyshkin, **Mohammed** et al. assertHE: an R package to improve quality assurance of health economic models. 2024. (https://wellcomeopenresearch.org/articles/9-701)

Automating Health Economic Evaluation with R (+genAI)

Smith, Lamrock**, Dolin, Lewis,** McQueen. R we almost there? Applying the advantages of modern software tools to the ICER Severe Asthma Model. In progress

Now a popular short course

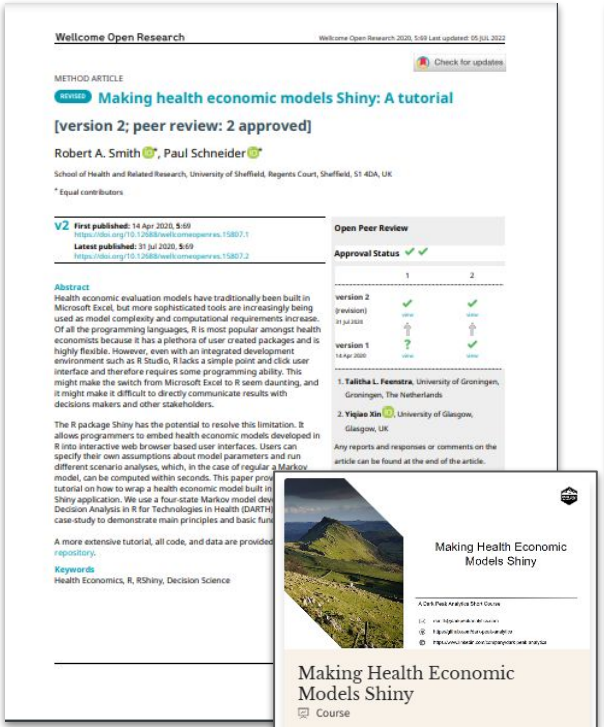


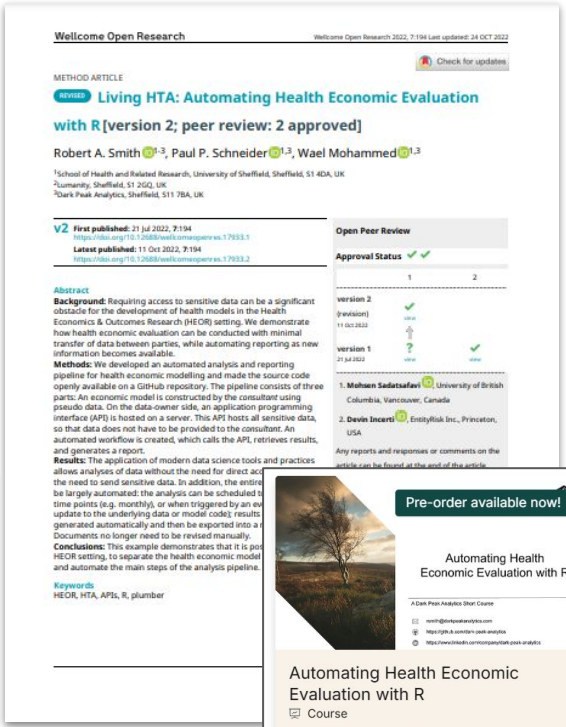
[Bibby](https://github.com/)
Open Source on GitHub

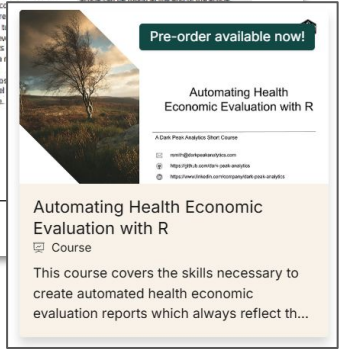
Tutorial Papers

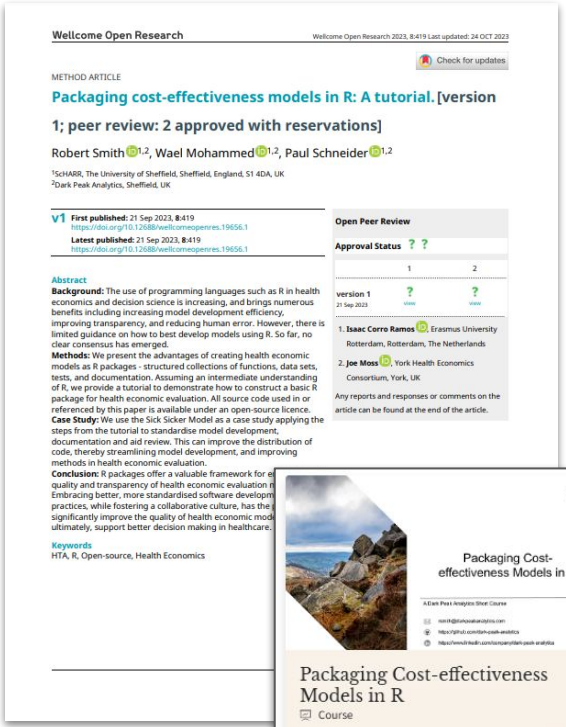
Early Publications

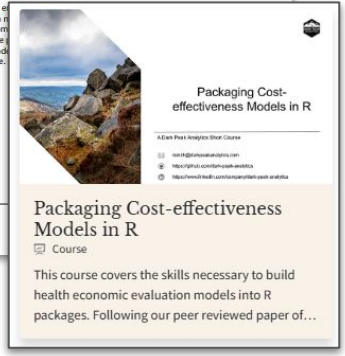
Our Tutorial Papers (and related courses)





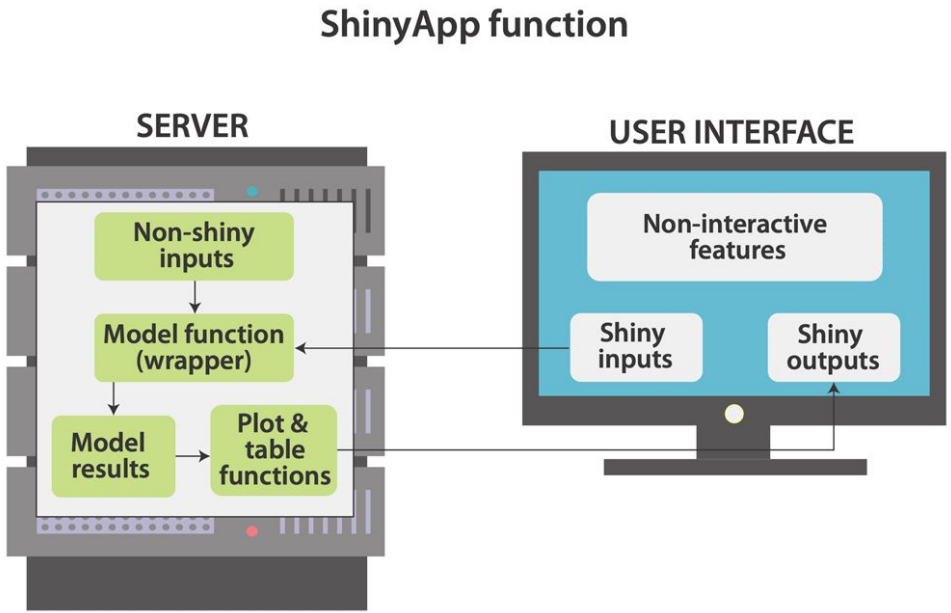






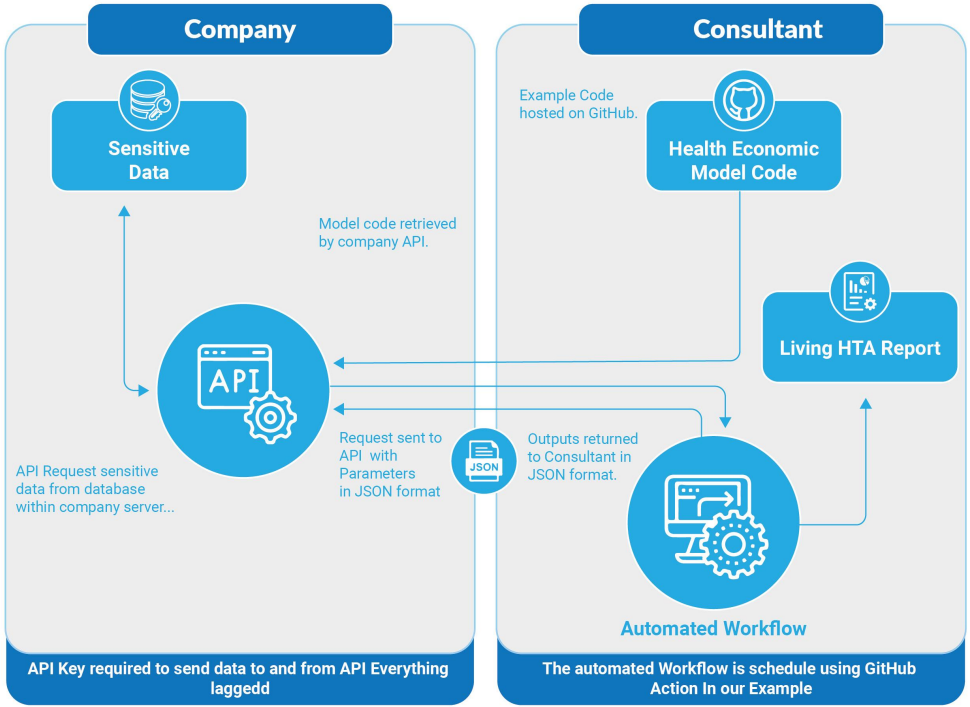
Tutorial Papers: *Smith and Schneider* (2020)

Making health economic models Shiny: A tutorial



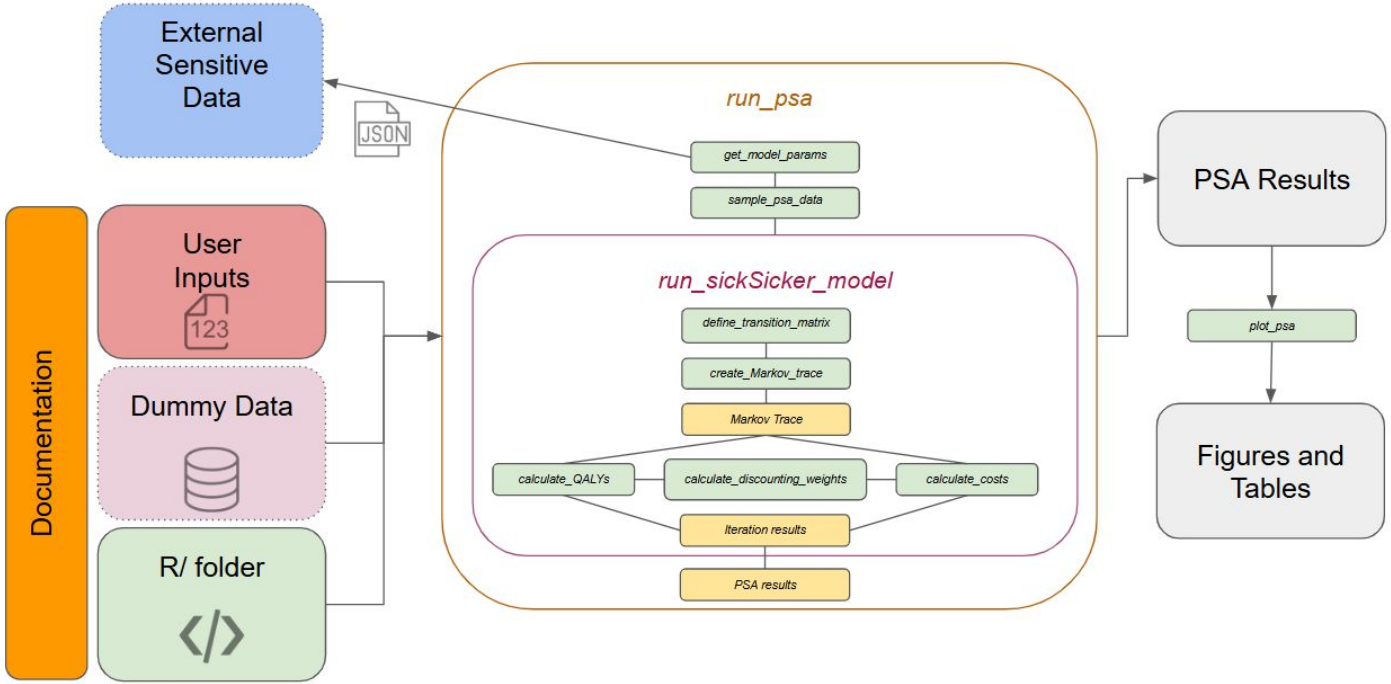
Tutorial Papers: *Smith et. al* (2022)

Living HTA: Automating Health Economic Evaluation with R



Tutorial Papers: *Smith et al.* (2023)

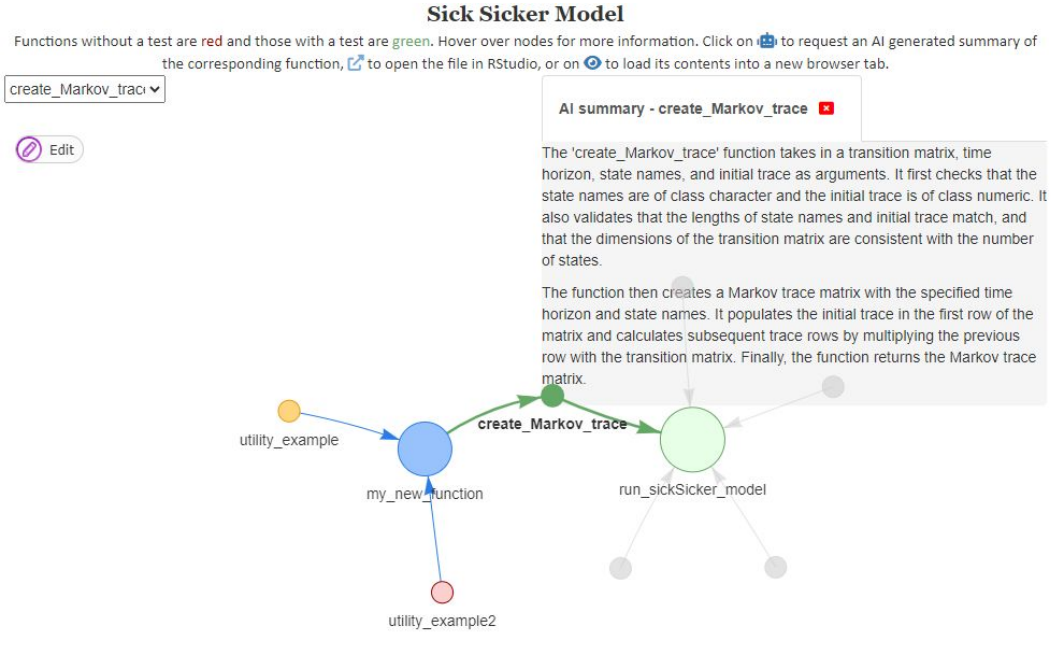
Packaging cost-effectiveness models in R: A tutorial

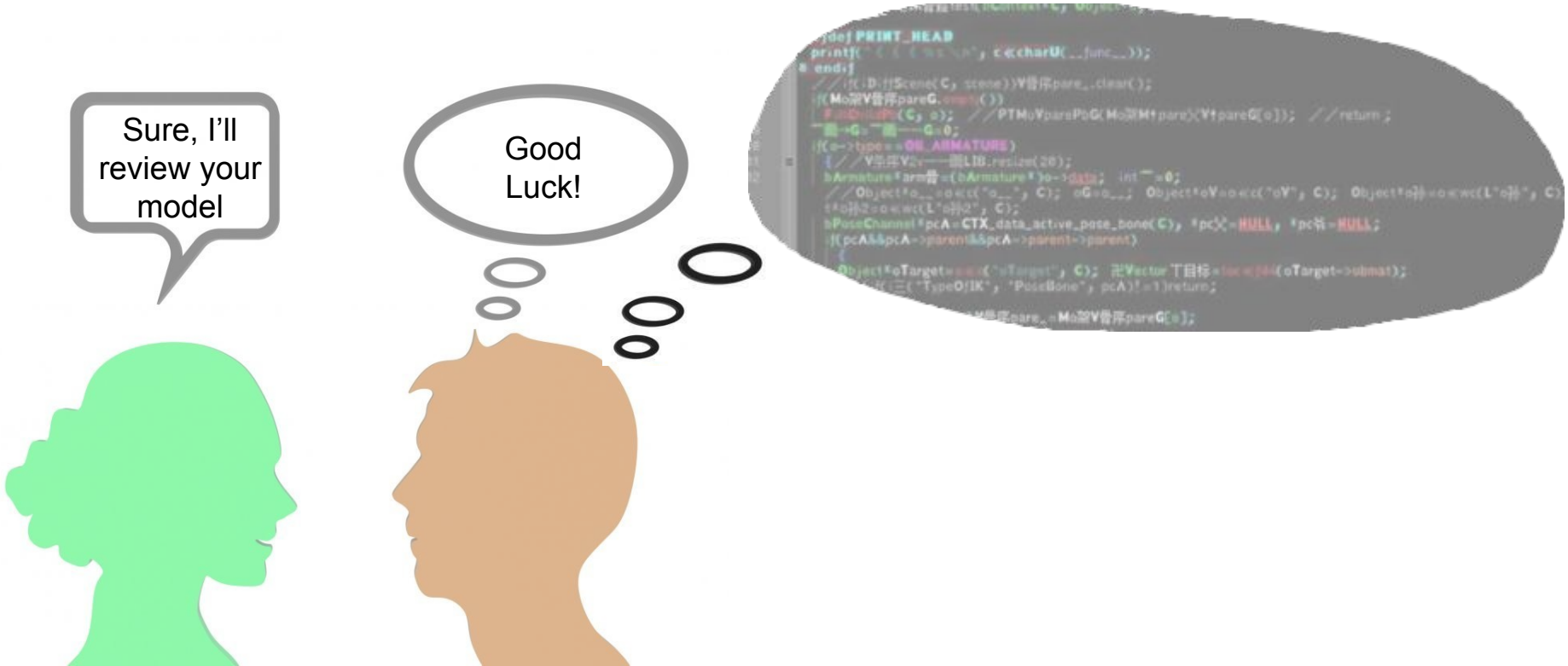


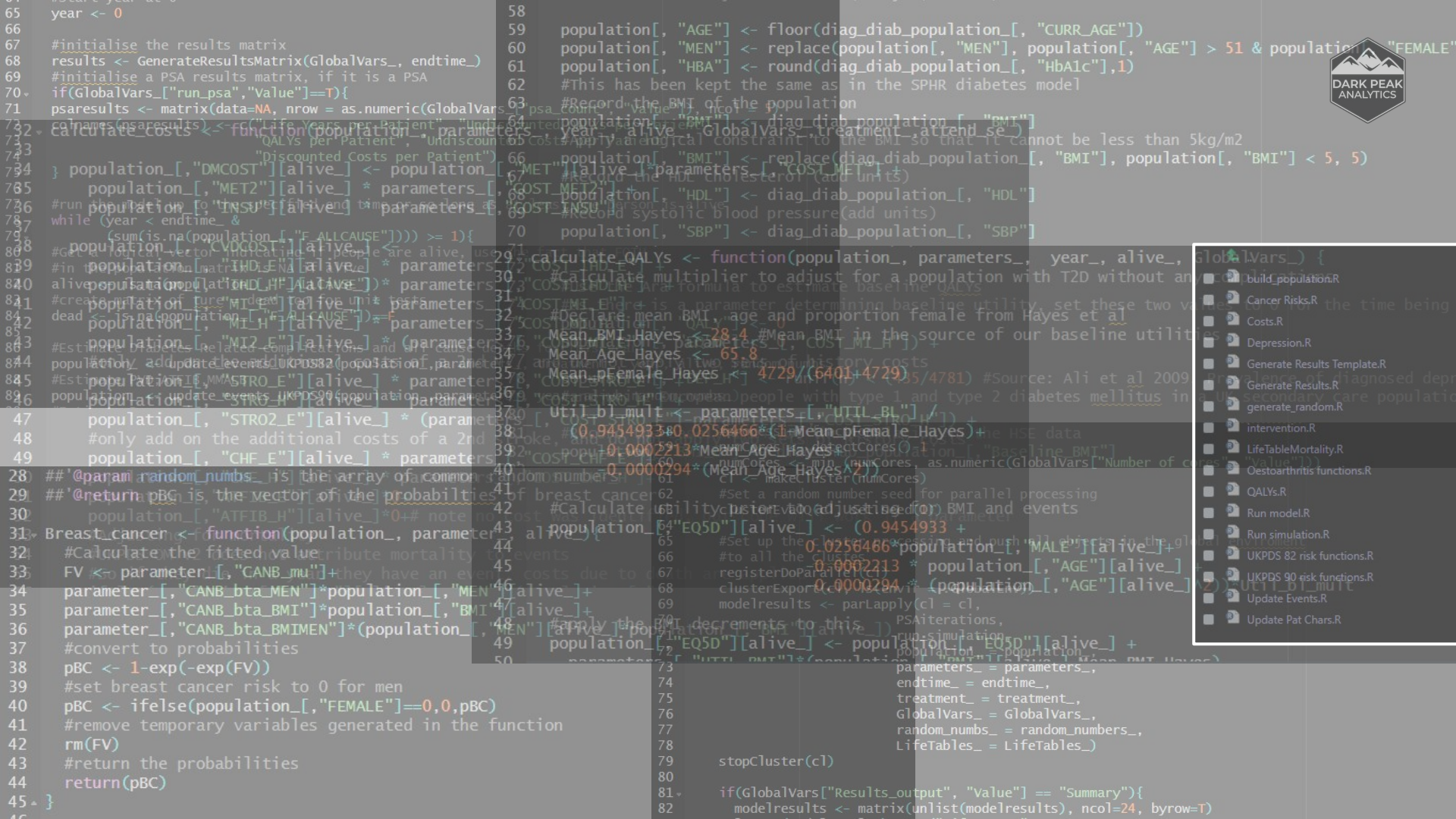
Software

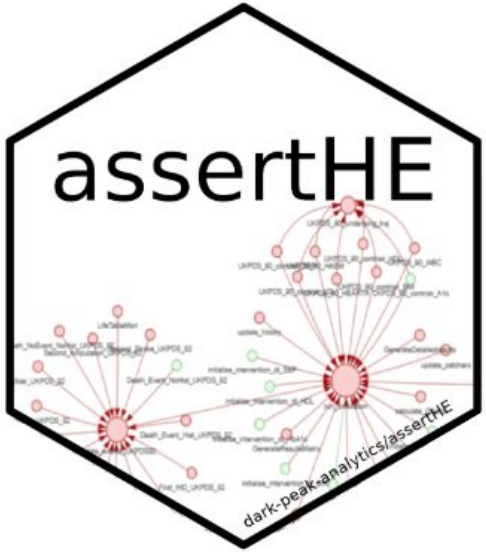
Tutorial Papers: *Smith et. al.* (2024)

assertHE: an R package to improve quality assurance of HTA models




Sure, I'll review your model
Good Luck!


DARK PEAK ANALYTICS
build_population.R
Cancer Risks.R
Costs.R
Depression.R
Generate Results Template.R
Generate Results.R
generate_random.R
intervention.R
LifeTableMortality.R
Oestoarthritis functions.R
QALYs.R
Run model.R
Run simulation.R
UKPDS 82 risk functions.R
UKPDS 90 risk functions.R
Update Events.R
Update Pat Chars.R


assertHE
dark-peak-analytics/assertHE

Publication

Wellcome Open Research

Wellcome Open Research 2024, 9:701 Last updated: 17 JUN 2025

Check for updates

SOFTWARE TOOL ARTICLE

assertHE: an R package to improve quality assurance of HTA models

[version 1; peer review: 1 approved, 1 approved with reservations]

Robert A. Smith[1,2], Yevgeniy Samyshkin[3], Wael Mohammed[1,2], Felicity Lamrock[4], Tom Ward[3,5], Jack Smith[1], Alan Martin[3], Paul Schneider[1,2], Dawn Lee[6], Gianluca Baio[7], Howard Thom[8], Nathan Green[7], Marina Richardson[9], Mohammed El Alili[10,11], Xavier Pouwels[12], Calum Lewis[1,2], Baris Deniz[3,13]

[1]Dark Peak Analytics, Sheffield, UK
[2]The University of Sheffield, Sheffield, UK
[3]GSK, London, UK
[4]Mathematical Sciences Research Centre, Queens University Belfast, Belfast, UK
[5]University of Exeter Medical School, Exeter, UK
[6]PenTAG, University of Exeter Medical School, Exeter, UK
[7]University College London Department of Statistical Science, London, UK
[8]Department of Population Health Sciences, University of Bristol Medical School, Bristol, UK
[9]Institute for Clinical and Economic Review (ICER), Boston, MA, USA
[10]Department of Health Sciences, Faculty of Science, Vrije Universiteit Amsterdam, Amsterdam Public Health Research Institute, Amsterdam, The Netherlands
[11]National Health Care Institute (ZIN), Diemen, The Netherlands
[12]Section of Health Technology and Services Research, University of Twente, Overijssel, The Netherlands
[13]Current Affiliation: Alde Solutions LLC, Wilmington, Delaware, USA

v1 **First published:** 02 Dec 2024, **9**:701
https://doi.org/10.12688/wellcomeopenres.23180.1
Latest published: 02 Dec 2024, **9**:701
https://doi.org/10.12688/wellcomeopenres.23180.1

Abstract

Background

Health economic models are increasingly used to inform decisions about the allocation of healthcare resources. Ensuring the robustness and reliability of these models is critical. Currently, quality assurance is conducted by both technical and non-technical experts assessing different components of the model manually. This is resource intensive. Understanding how the different components of the model fit together is time consuming, and testing every part of the model is sometimes not feasible in the time available. To aid in this, we have developed the assertHE R package.

Open Peer Review

Approval Status ? ✓

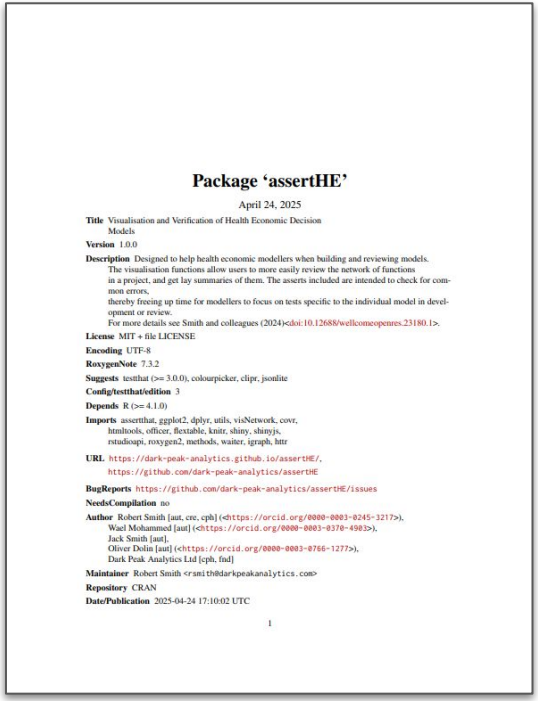
	1	2
version 1 02 Dec 2024	? view	✓ view

1. **Alexandra Hill**, London School of Hygiene & Tropical Medicine, London, UK
2. **Alfredo Mariani**, The National Institute for Health and Care Excellence (NICE), London, UK

Any reports and responses or comments on the article can be found at the end of the article.

Smith et al. assertHE: an R package to improve quality assurance of HTA models. doi.org/10.12688/wellcomeopenres.23180.1

CRAN Package



Package 'assertHE'

April 24, 2025

Title Visualisation and Verification of Health Economic Decision Models

Version 1.0.0

Description Designed to help health economic modellers when building and reviewing models. The visualisation functions allow users to more easily review the network of functions in a project, and get lay summaries of them. The asserts included are intended to check for common errors, thereby freeing up time for modellers to focus on tests specific to the individual model in development or review. For more details see Smith and colleagues (2024)<doi:10.12688/wellcomeopenres.23180.1>.

License MIT + file LICENSE

Encoding UTF-8

RoxygenNote 7.3.2

Suggests testthat (>= 3.0.0), colourpicker, clipr, jsonlite

Config/testthat/edition 3

Depends R (>= 4.1.0)

Imports assertthat, ggplot2, dplyr, utils, visNetwork, covr, htmltools, officer, flextable, knitr, shiny, shinyjs, rstudioapi, roxygen2, methods, waiter, igraph, httr

URL https://dark-peak-analytics.github.io/assertHE/, https://github.com/dark-peak-analytics/assertHE

BugReports https://github.com/dark-peak-analytics/assertHE/issues

NeedsCompilation no

Author Robert Smith [aut, cre, cph] (<https://orcid.org/0000-0003-0245-3217>), Wael Mohammed [aut] (<https://orcid.org/0000-0003-0370-4903>), Jack Smith [aut], Oliver Dolin [aut] (<https://orcid.org/0000-0003-0766-1277>), Dark Peak Analytics Ltd [cph, fnd]

Maintainer Robert Smith <rsmith@darkpeakanalytics.com>

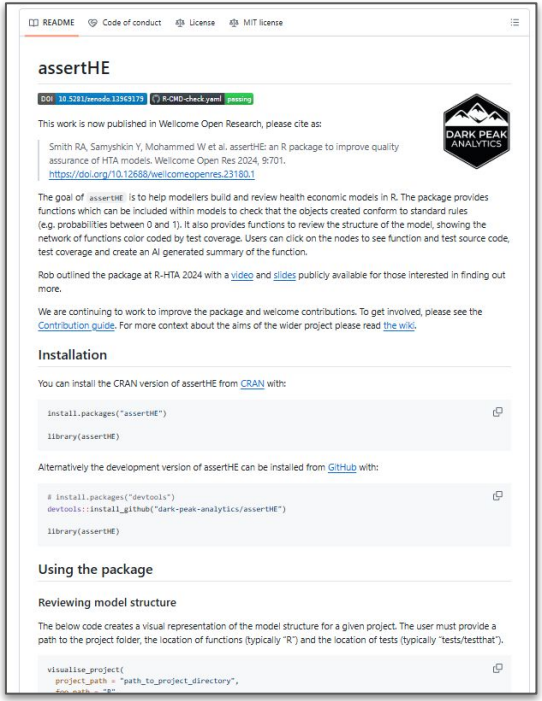
Repository CRAN

Date/Publication 2025-04-24 17:10:02 UTC

1

packages/assertHE/index.html

GitHub Repo



README Code of conduct License MIT license

assertHE

DOI 10.5281/zenodo.13963179 R-CMD-check.yaml passing

This work is now published in Wellcome Open Research, please cite as:

> Smith RA, Samyshkin Y, Mohammed W et al. assertHE: an R package to improve quality assurance of HTA models. Wellcome Open Res 2024, 9:701. https://doi.org/10.12688/wellcomeopenres.23180.1

The goal of `assertHE` is to help modellers build and review health economic models in R. The package provides functions which can be included within models to check that the objects created conform to standard rules (e.g. probabilities between 0 and 1). It also provides functions to review the structure of the model, showing the network of functions color coded by test coverage. Users can click on the nodes to see function and test source code, test coverage and create an AI generated summary of the function.

Rob outlined the package at R-HTA 2024 with a video and slides publicly available for those interested in finding out more.

We are continuing to work to improve the package and welcome contributions. To get involved, please see the Contribution guide. For more context about the aims of the wider project please read the wiki.

Installation

You can install the CRAN version of assertHE from CRAN with:

```
install.packages("assertHE")

library(assertHE)
```

Alternatively the development version of assertHE can be installed from GitHub with:

```
# install.packages("devtools")
devtools::install_github("dark-peak-analytics/assertHE")

library(assertHE)
```

Using the package

Reviewing model structure

The below code creates a visual representation of the model structure for a given project. The user must provide a path to the project folder, the location of functions (typically "R") and the location of tests (typically "tests/testthat").

```
visualise_project(
  project_path = "path_to_project_directory",
```

dark-peak-analytics.github.io/assertHE/

assertHE R package

Aim:

Help modellers **build** and **review** health economic models in R.

Functionality:

Check that the objects created in models conform to standard rules (e.g. probabilities between 0 and 1).

Summarise & visualise the structure of a model

- Plot function network color coded by test coverage.
- Click on the nodes to see function and test source code and test coverage.
- Display a LLM generated summary of any function.

https://github.com/dark-peak-analytics/assertHE

Using the *assertHE* R package

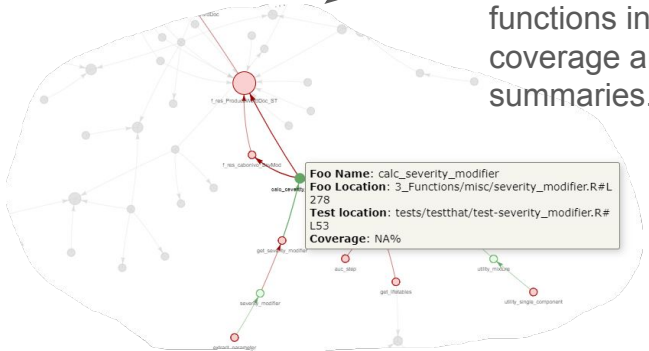
```
install.packages("assertHE")

library(assertHE)
```

A: visualise network of functions

```
visualise_project(
  project_path = "path_to_project_directory",
  foo_path = "R",
  test_path = "tests/testthat",
  run_coverage = T)
```

Inspect the network to understand how the model functions interact, their test coverage and get AI function summaries.



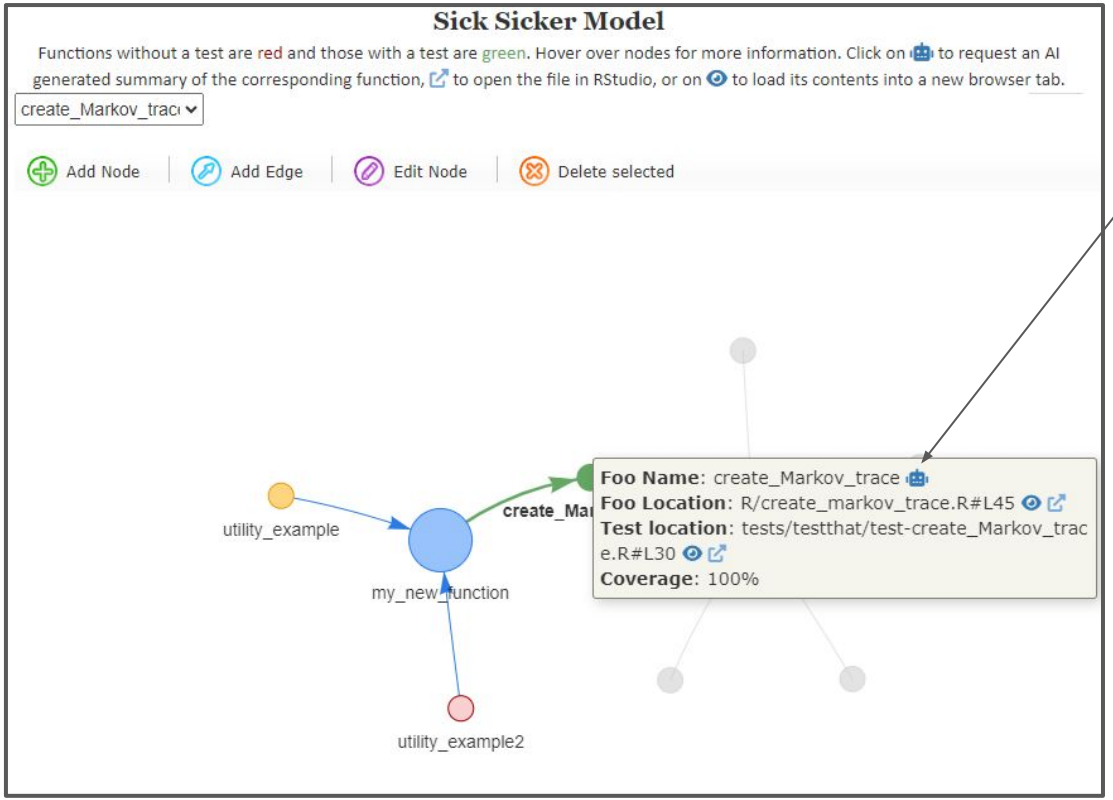
B: insert checks for common errors into the code

```
check_trans_prob_array(a_P = a_P,
                       stop_if_not = T)
```

Flags if there are errors or potential problems.

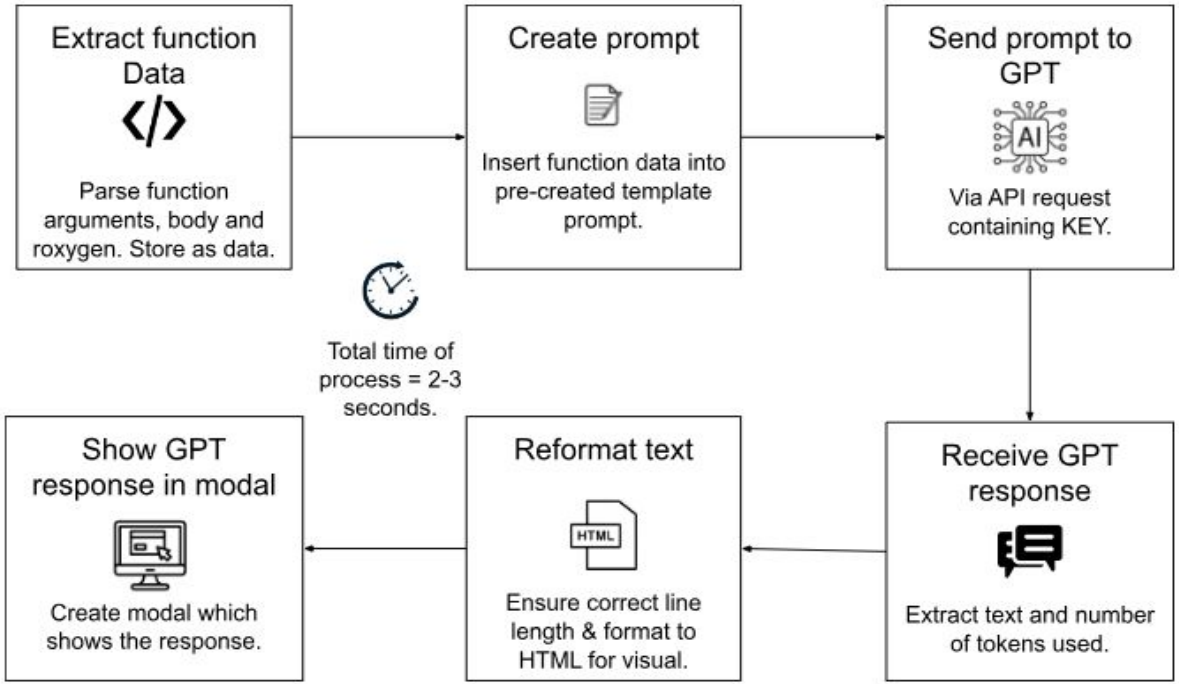
```
# Warning message:
# In check_array_rows_balanced(a_P, stop_if_not = stop_if_not) :
#   Not valid transition probabilities
#    Transition probabilities not valid from Health States:
# 1                                        H; at cycle 1
# 2                                        H; at cycle 2
# 3                                        H; at cycle 3
# 4                                        H; at cycle 4
# 5                                        H; at cycle 5
# 6                                        H; at cycle 6
# 7                                        H; at cycle 7
# 8                                        H; at cycle 8
# 9                                        H; at cycle 9
# 10                                      H; at cycle 10
```

assertHE model reviewer

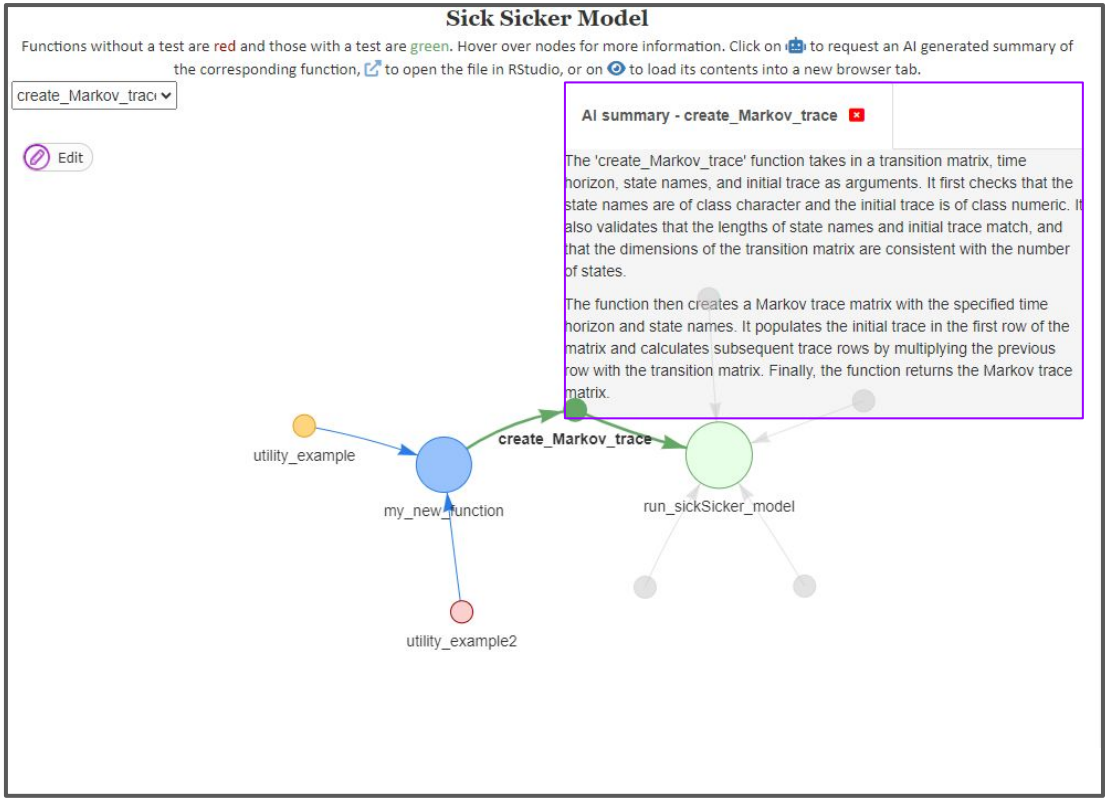


Generate LLM summary of function.

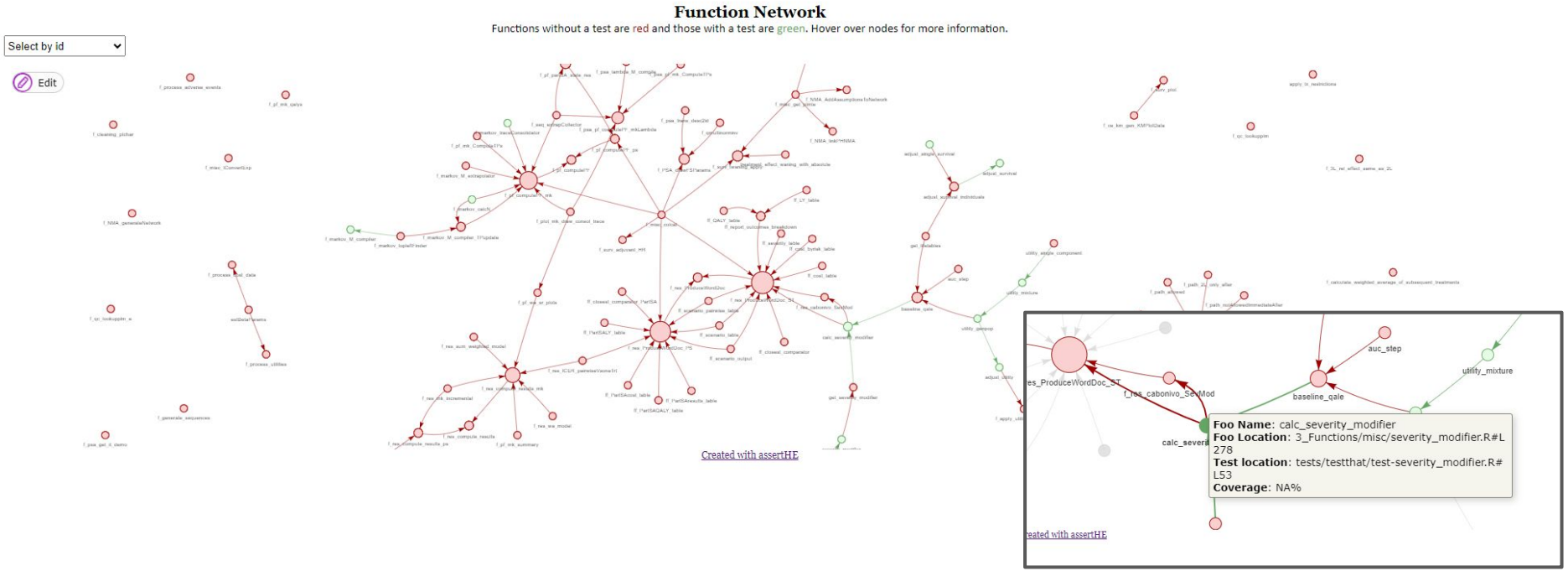
assertHE model reviewer



assertHE model reviewer



Case Study: NICE RCC Pilot

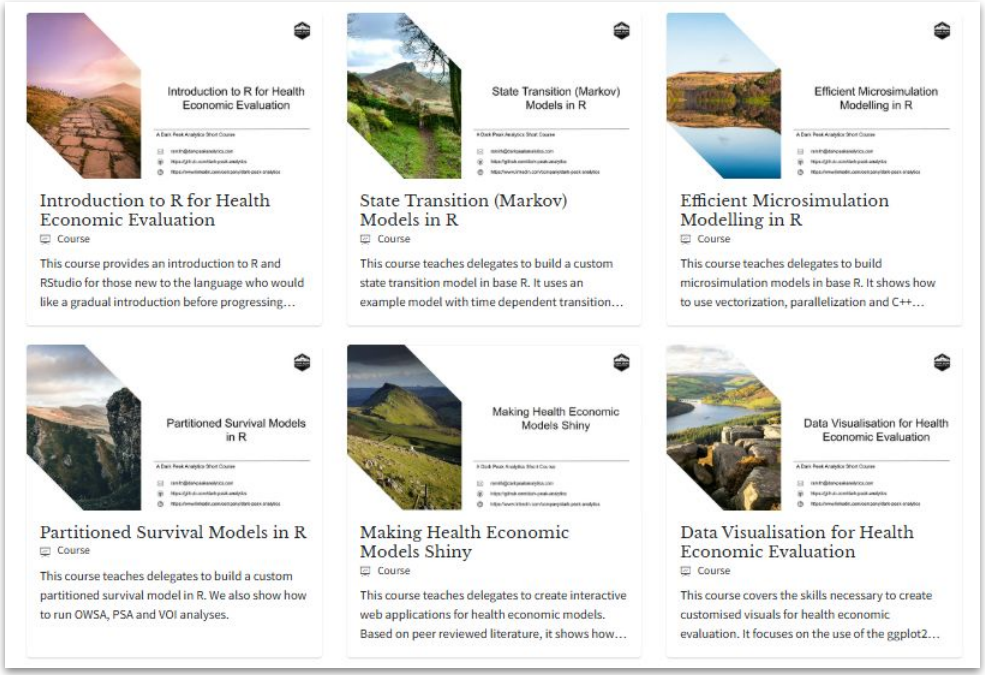


https://vimeo.com/934769366/4895265e53?share=copy

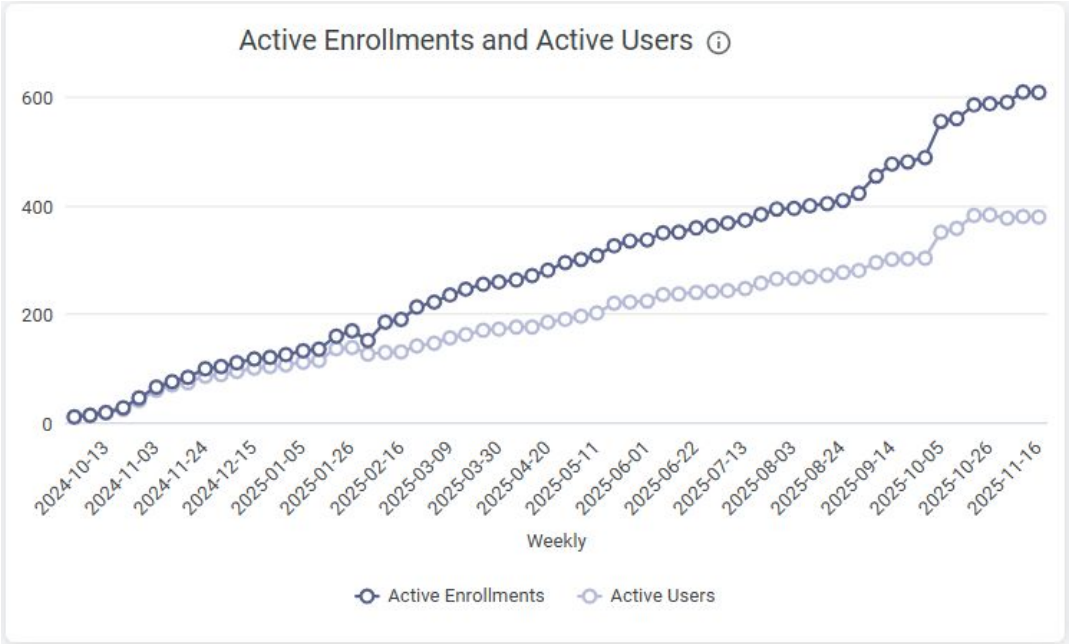
https://github.com/nice-digital/NICE-model-repo

Training

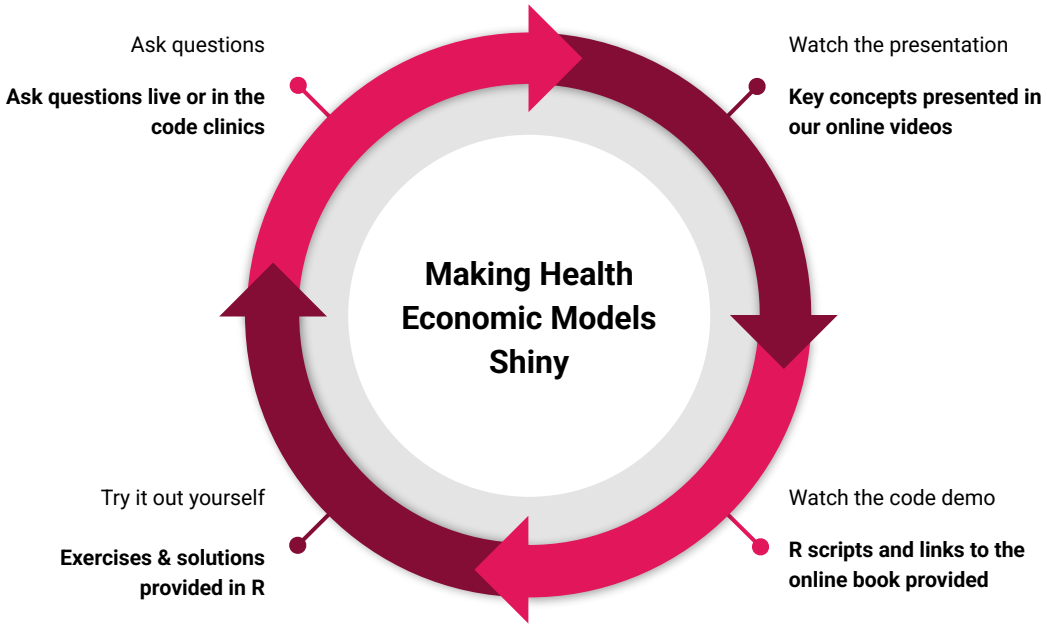
Short Courses



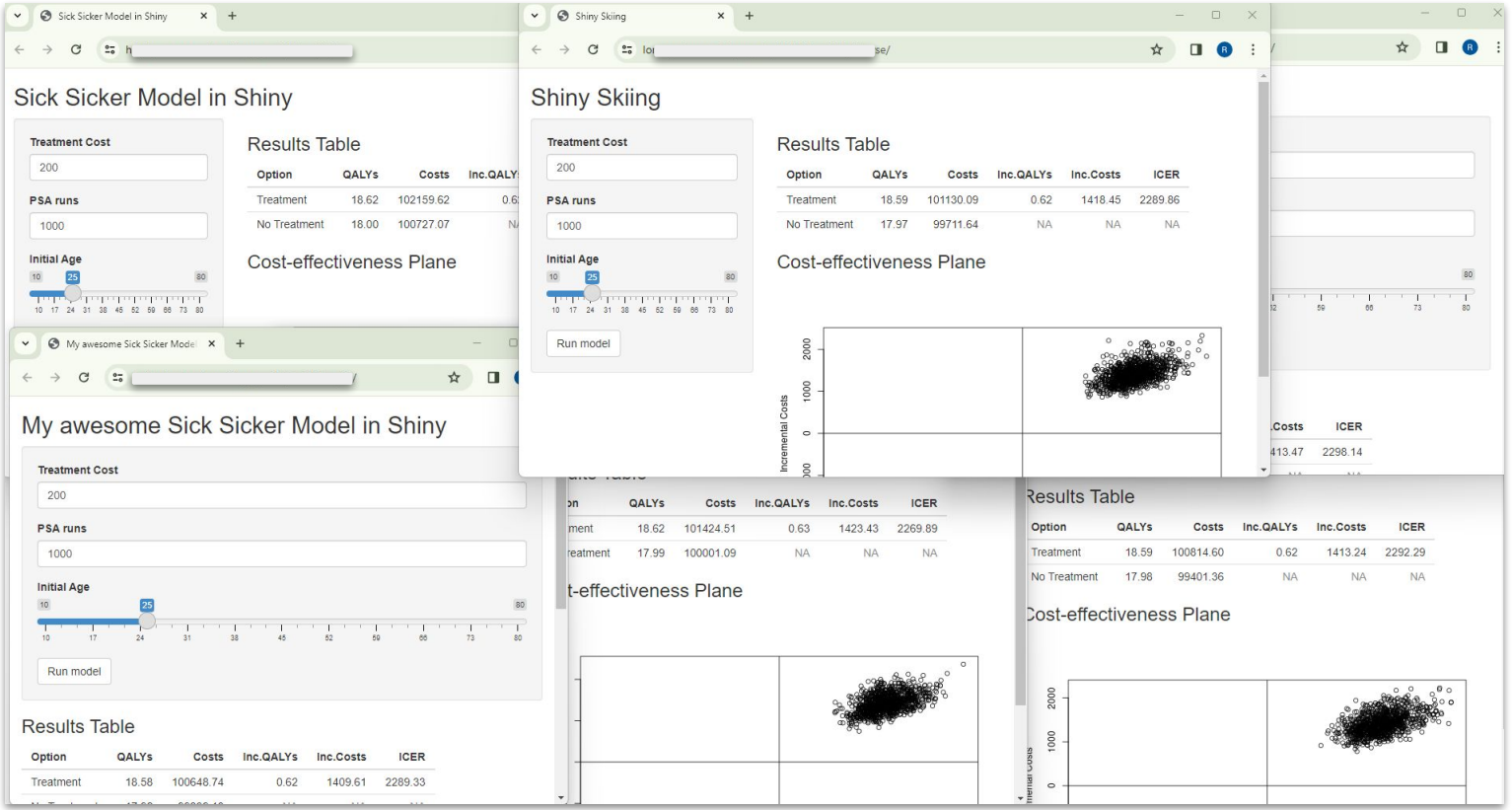
Short Courses



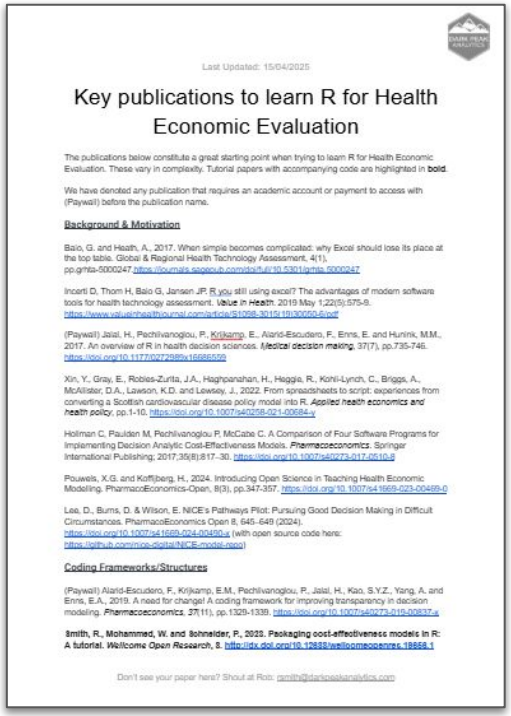
Case Study: Shiny



Case study - Our course delegates' apps



Reading list



Last Updated: 15/04/2025

Key publications to learn R for Health Economic Evaluation

The publications below constitute a great starting point when trying to learn R for Health Economic Evaluation. These vary in complexity. Tutorial papers with accompanying code are highlighted in **bold**.

We have denoted any publication that requires an academic account or payment to access with (Paywall) before the publication name.

Background & Motivation

Baio, G. and Heath, A., 2017. When simple becomes complicated: why Excel should lose its place at the top table. Global & Regional Health Technology Assessment, 4(1), pp.grhta-5000247.https://journals.sagepub.com/doi/full/10.5301/grhta.5000247

Incerti D, Thom H, Baio G, Jansen JP. R you still using excel? The advantages of modern software tools for health technology assessment. *Value in Health*. 2019 May 1;22(5):575-8. https://www.valueinhealthjournal.com/article/S1098-3015(19)30050-6/pdf

(Paywall) Jalal, H., Pechlivanoglou, P., Krijkamp, E., Alarid-Escudero, F., Enns, E. and Hunink, M.M., 2017. An overview of R in health decision sciences. *Medical decision making*, 37(7), pp.735-746. https://doi.org/10.1177/0272989x16686559

Xin, Y., Gray, E., Robles-Zurita, J.A., Haghpanahan, H., Heggie, R., Kohli-Lynch, C., Briggs, A., McAllister, D.A., Lawson, K.D. and Lewsey, J., 2022. From spreadsheets to script: experiences from converting a Scottish cardiovascular disease policy model into R. *Applied health economics and health policy*, pp.1-10. https://doi.org/10.1007/s40258-021-00684-y

Hollman C, Paulden M, Pechlivanoglou P, McCabe C. A Comparison of Four Software Programs for Implementing Decision Analytic Cost-Effectiveness Models. *Pharmacoeconomics*. Springer International Publishing; 2017;35(8):817–30. https://doi.org/10.1007/s40273-017-0510-8

Pouwels, X.G. and Koffijberg, H., 2024. Introducing Open Science in Teaching Health Economic Modelling. PharmacoEconomics-Open, 8(3), pp.347-357. https://doi.org/10.1007/s41669-023-00469-0

Lee, D., Burns, D. & Wilson, E. NICE's Pathways Pilot: Pursuing Good Decision Making in Difficult Circumstances. PharmacoEconomics Open 8, 645–649 (2024). https://doi.org/10.1007/s41669-024-00490-x (with open source code here: https://github.com/nice-digital/NICE-model-repo)

Coding Frameworks/Structures

(Paywall) Alarid-Escudero, F., Krijkamp, E.M., Pechlivanoglou, P., Jalal, H., Kao, S.Y.Z., Yang, A. and Enns, E.A., 2019. A need for change! A coding framework for improving transparency in decision modeling. *Pharmacoeconomics*, *37*(11), pp.1329-1339. https://doi.org/10.1007/s40273-019-00837-x

Smith, R., Mohammed, W. and Bohnstedt, P., 2023. Packaging cost-effectiveness models in R: A tutorial. *Wellcome Open Research*, 8. http://dx.doi.org/10.12688/wellcomeopenres.18868.1

Don't see your paper here? Shout at Rob: rsmith@darkpeakanalytics.com

https://www.courses.darkpeakanalytics.com/products/digital_downloads/health-economic-evaluation-reading-list

DARK PEAK ANALYTICS

Platforms

Why is shiny so important?

Health economic models play a crucial role in decision making

There is often a trade-off between usability and external validity

Improvements in technology can help mitigate the trade-off

"*Authors of modelling papers can do things to make their work substantially more useful for policy. The best is to provide an interactive interface, where if the policymaker does not agree with the starting assumptions of the model, they can change them.*" (Whitty, 2015)

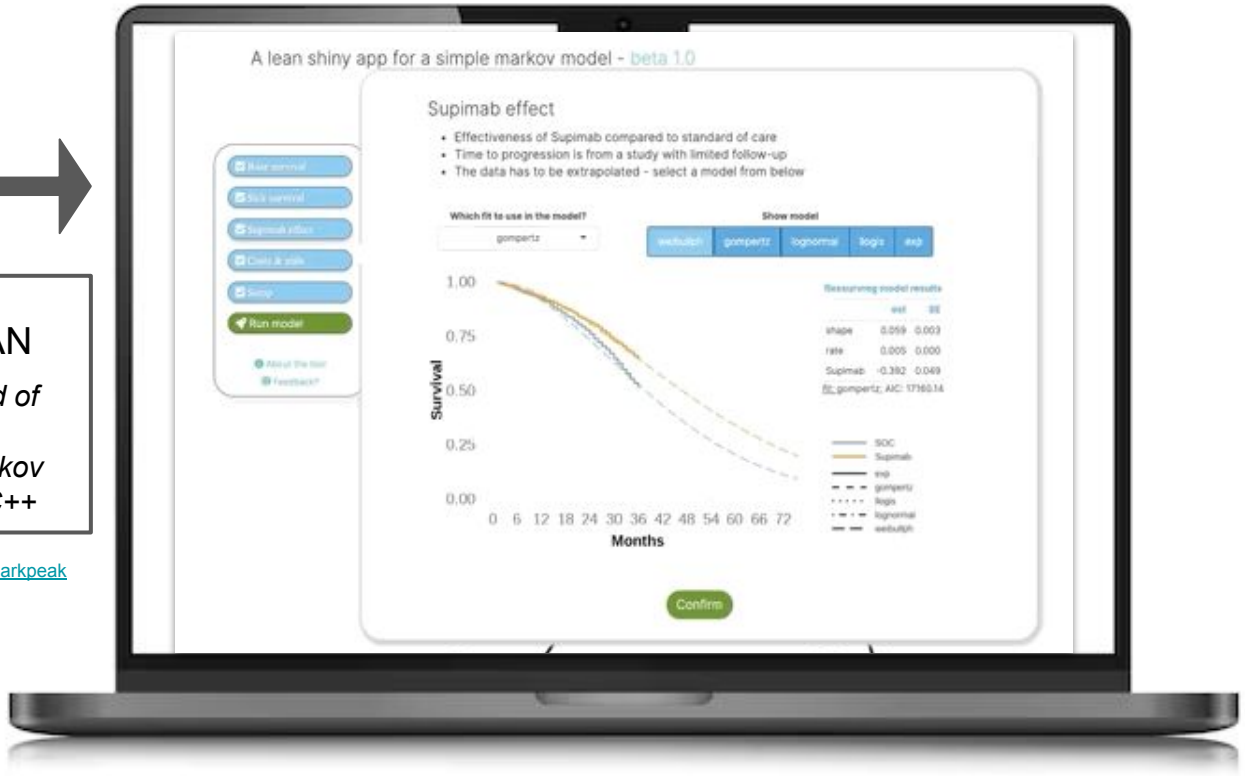
Prof Sir Chris Whitty

Open-source model

GitHub/CRAN

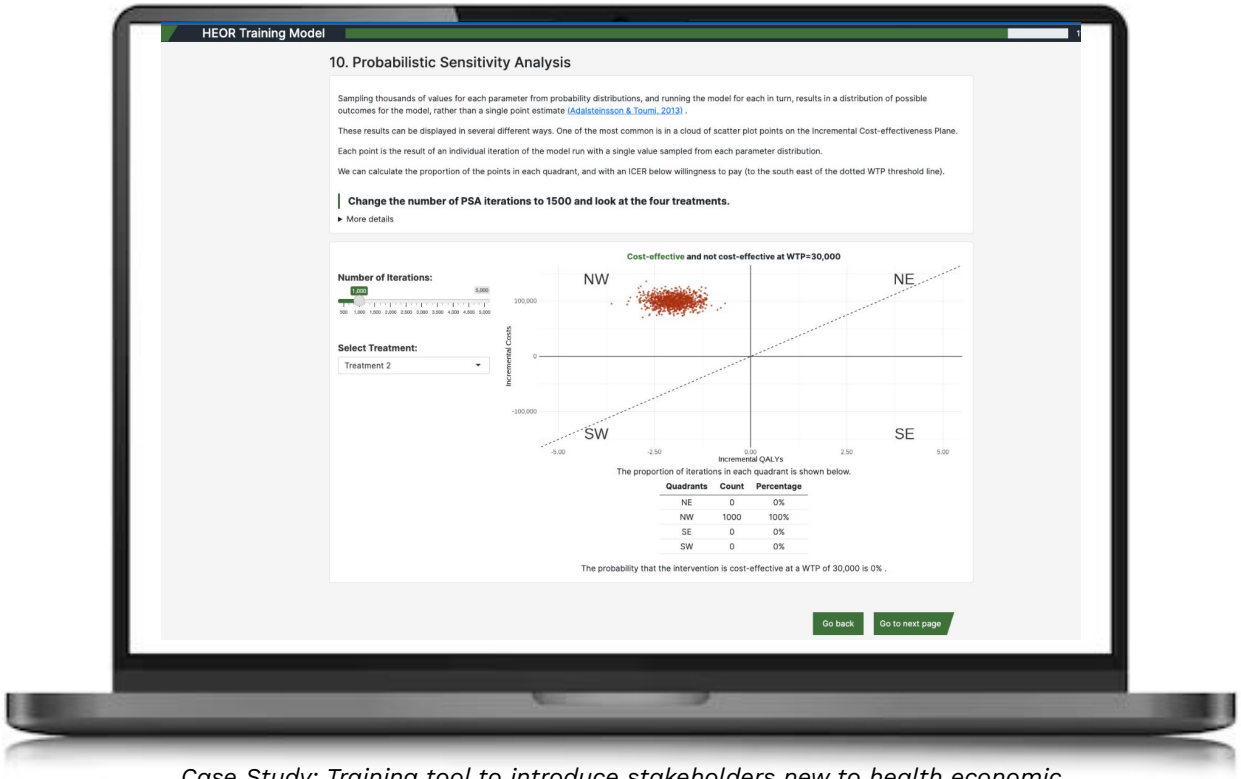
A faster method of running time dependent markov models using C++

https://github.com/dark-peak-analytics/darkpeak



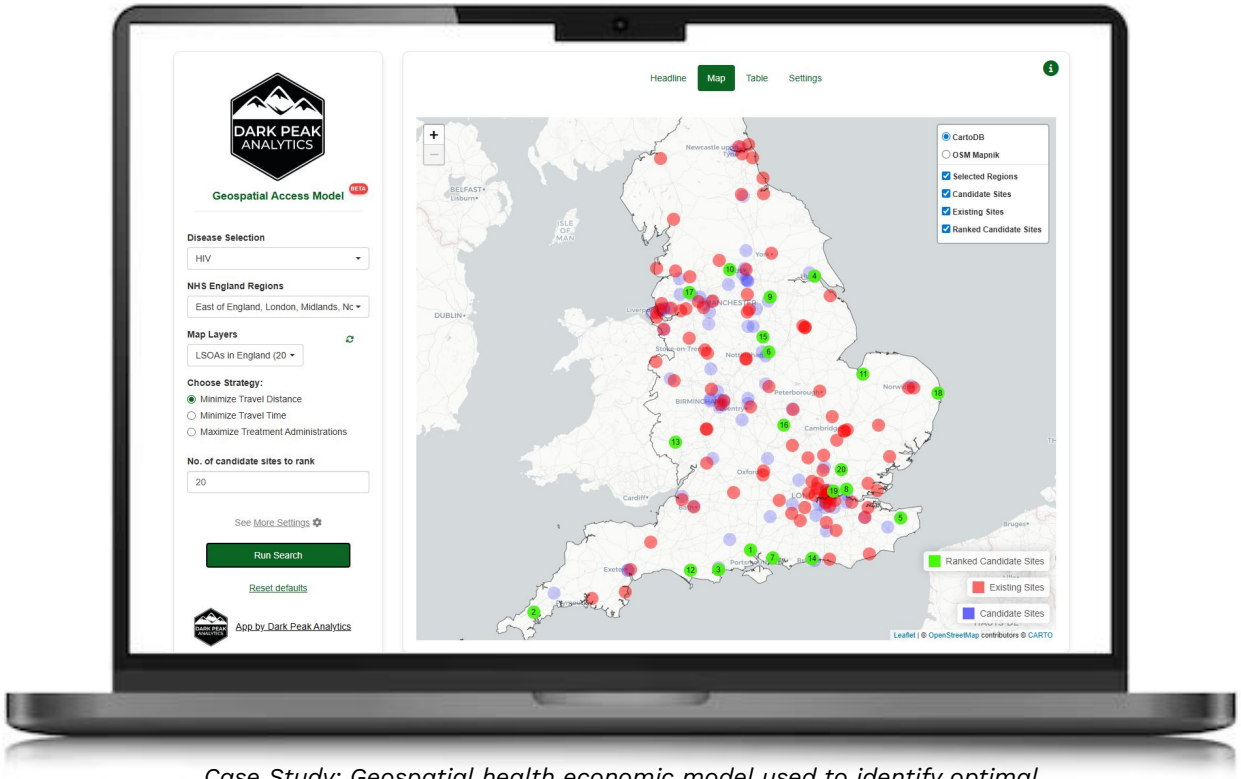
https://darkpeakanalytics.shinyapps.io/sadm-mk2/

Case study - Health Economic Training Tool



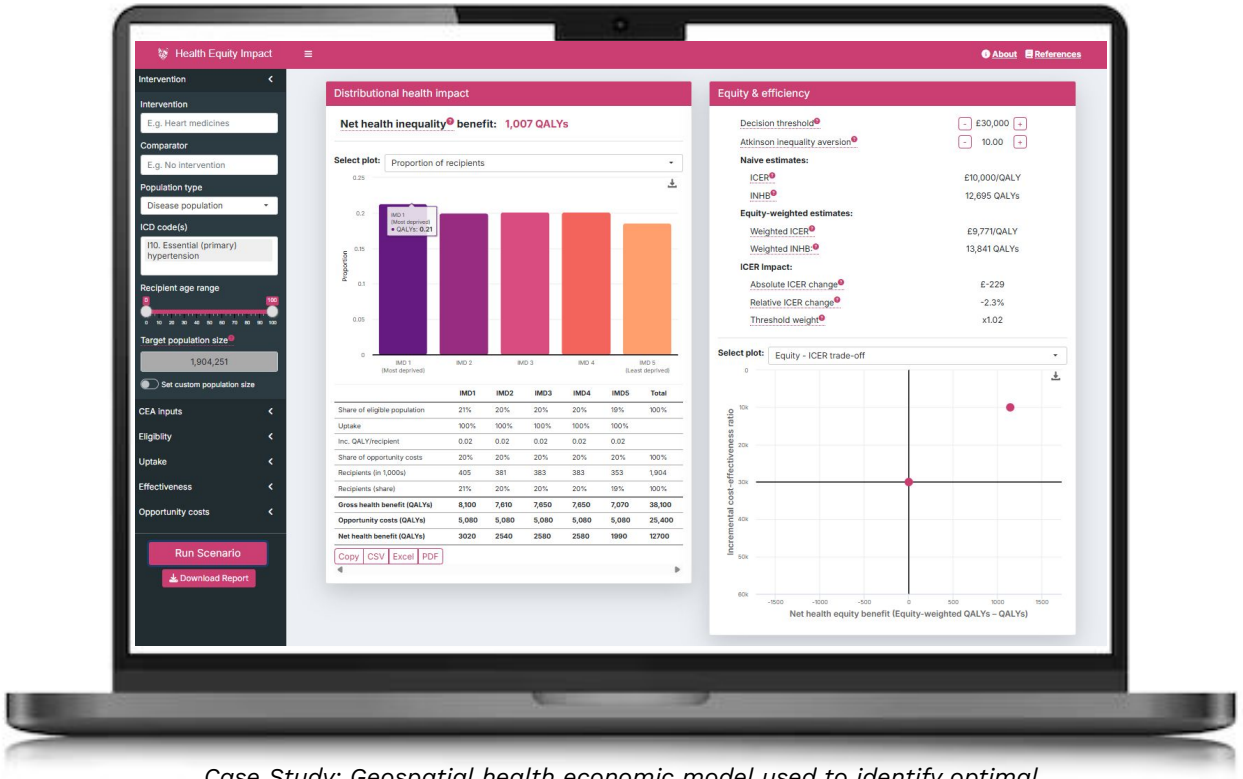
Case Study: Training tool to introduce stakeholders new to health economic modelling through the components of a model

Case study - Geospatial Health Economic Model



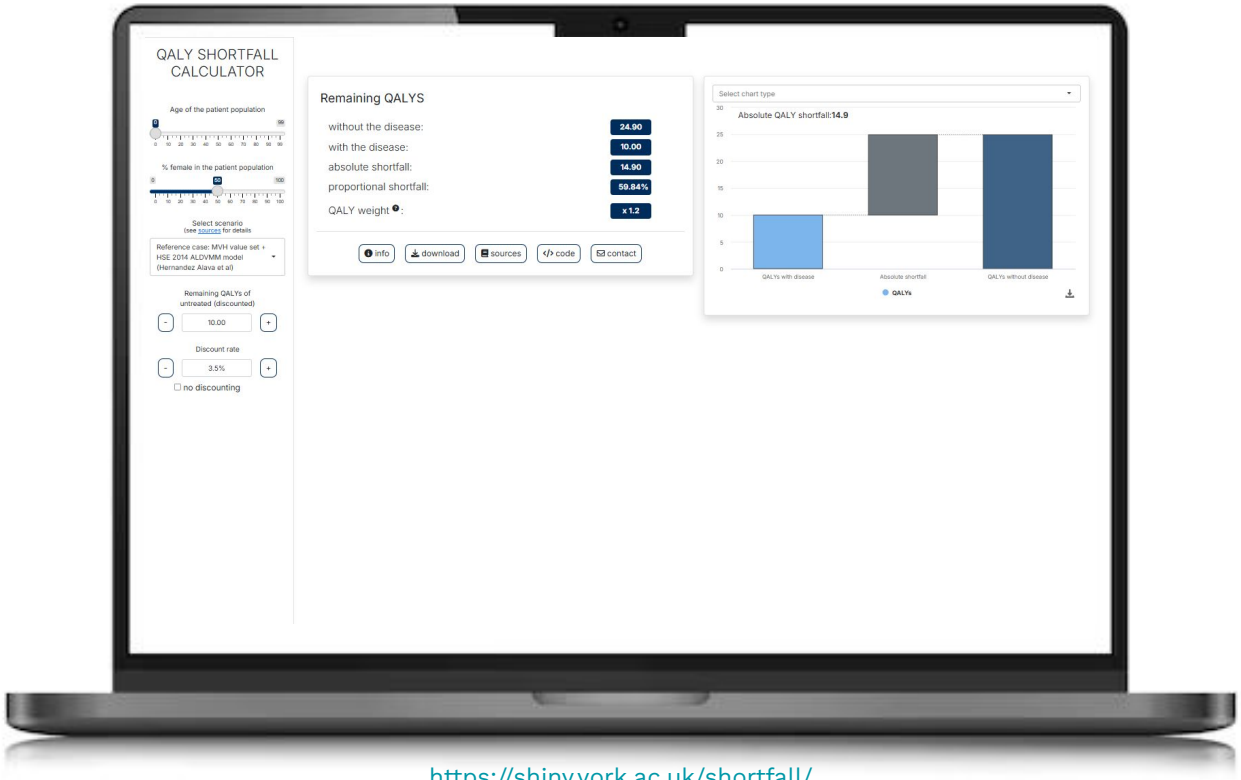
Case Study: Geospatial health economic model used to identify optimal healthcare sites for HCP administered medicines.

Case study - DCEA tool



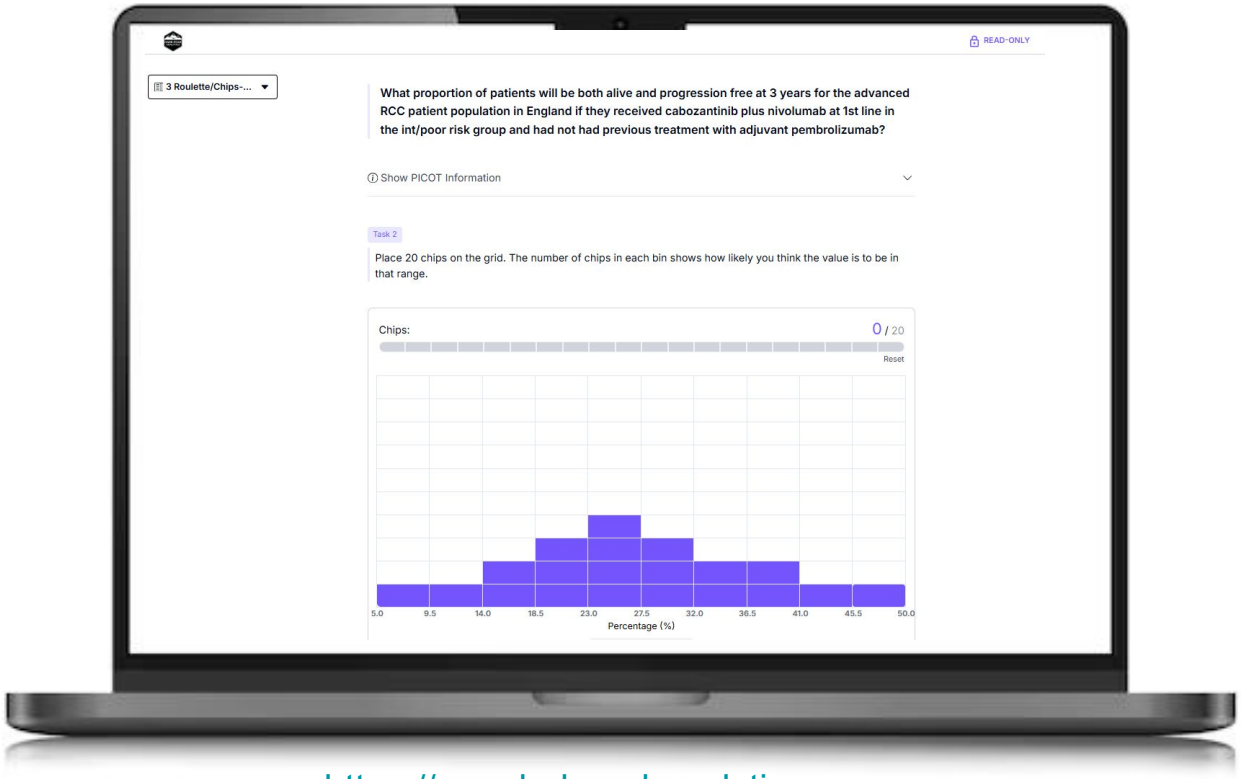
Case Study: Geospatial health economic model used to identify optimal healthcare sites for HCP administered medicines.

Case study - Shortfall tool



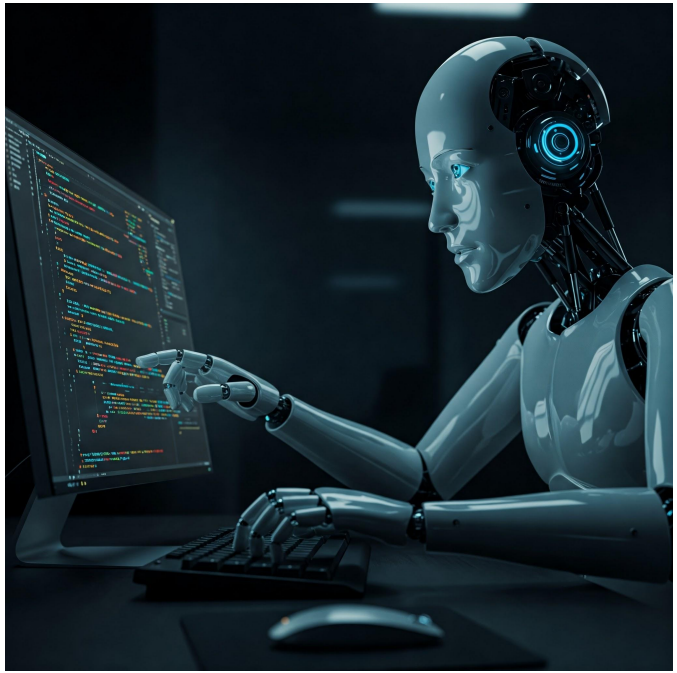
https://shiny.york.ac.uk/shortfall/

Case study - Structured Expert Elicitation Tool



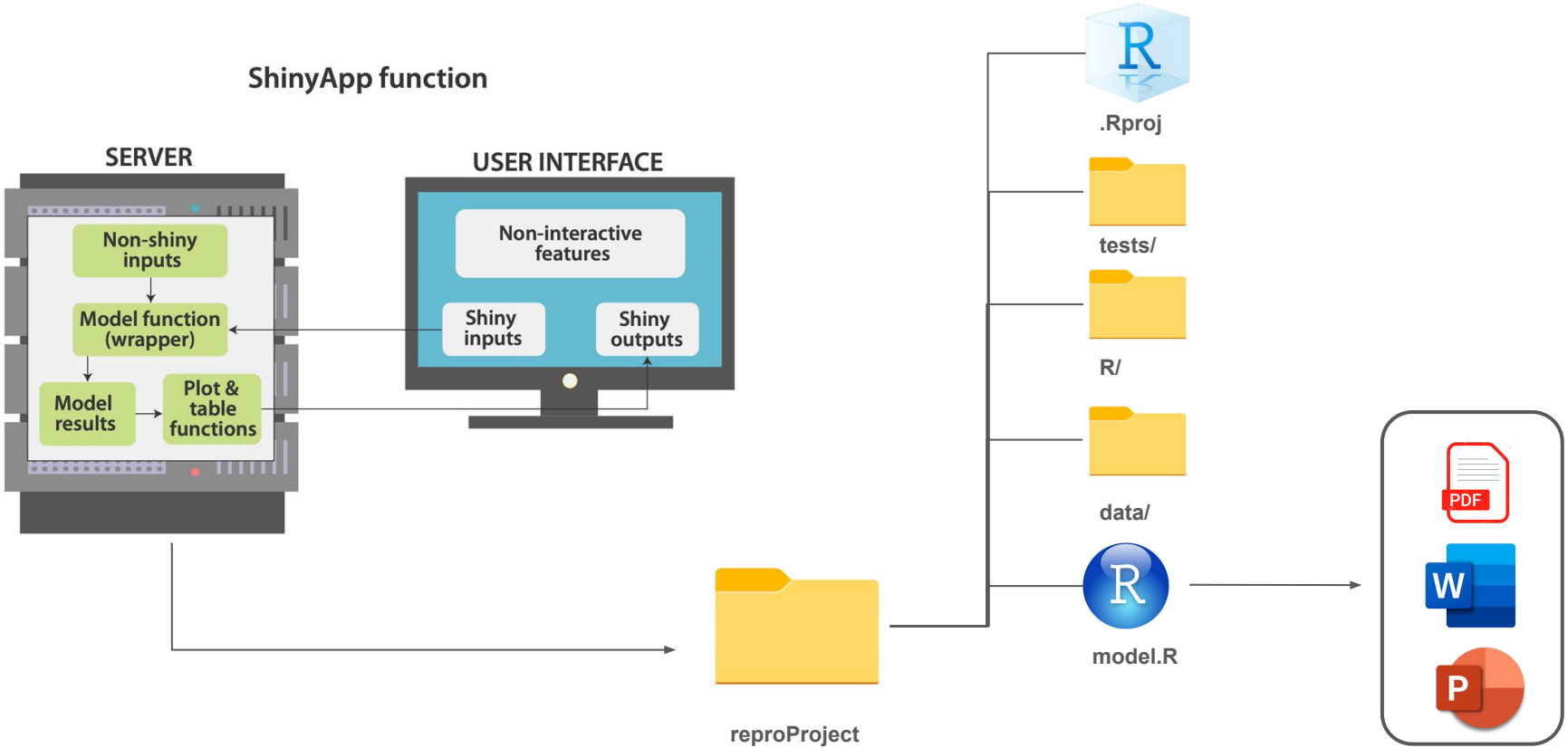
https://see.darkpeakanalytics.com

genAI for HEOR - not designed for Excel

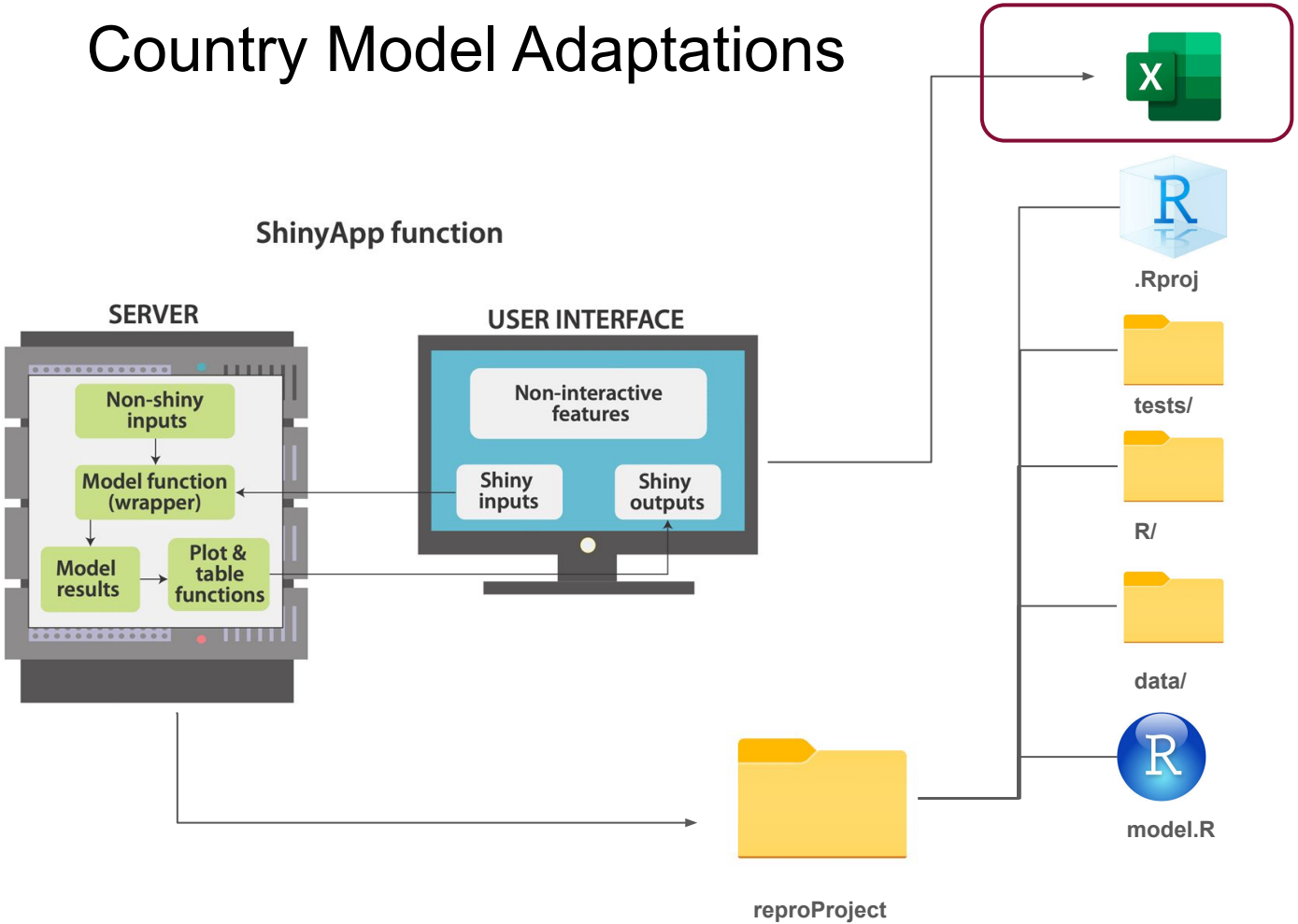


New developments

Reproducible outputs



Country Model Adaptations



Deploying shiny apps within a company (VitaCure)

DPA Project Repository

(Code only)

</>

DPA Dev App

Fork (2 min job)

VitaCure Project Repository (Code + Data)

</>

VitaCure Local App

automated deployment on code update

VitaCure App Deployment (Code + Data)

</>

VitaCure Production App

Conclusions