assertHE:
HTA R model review

R-HTA 24 | Robert Smith & Tom Ward | June 2024

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

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Acknowledgements

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Package contributors:
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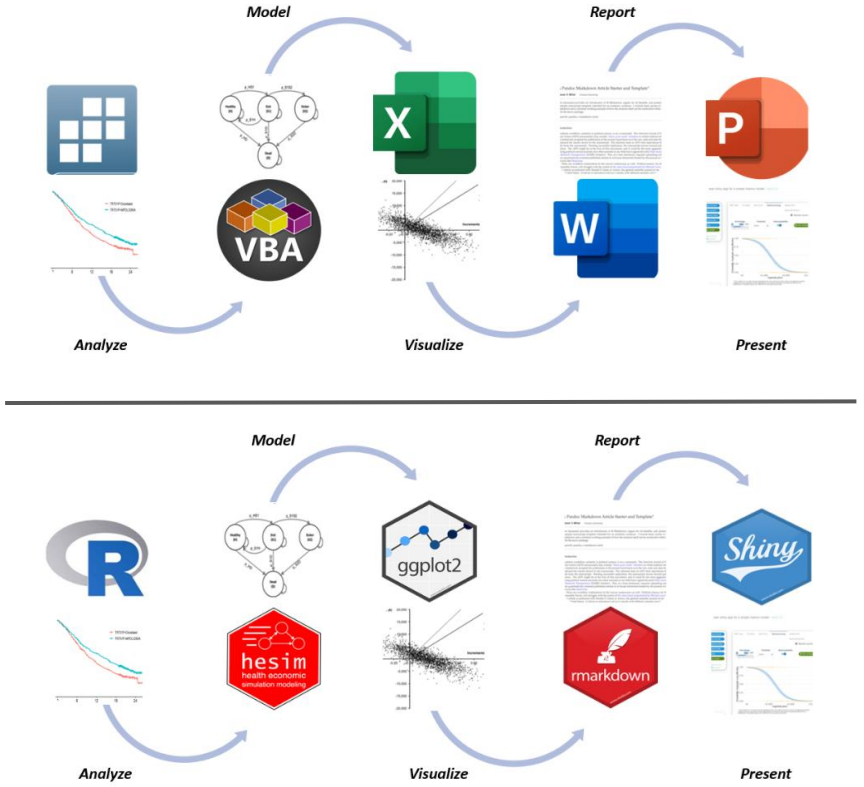
Overarching aim

Shifting the HTA modelling pipeline from spreadsheet software (e.g. MS Excel) to script based programming languages (e.g R).

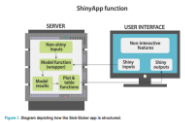


Related publications

2019 2020 2021 2022 2023 2024

Making Health Economic Models Shiny: A tutorial

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



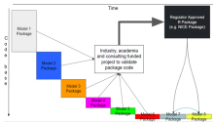
covid-19 work

Living HTA: Automating Health Economic Evaluation with R

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

Packaging cost-effectiveness models in R: A tutorial.

Smith RA, Mohammed W and **Schneider PP**. R Packaging cost-effectiveness models in R: A tutorial. 2023. (https://wellcomeopenresearch.org/articles/8-419)



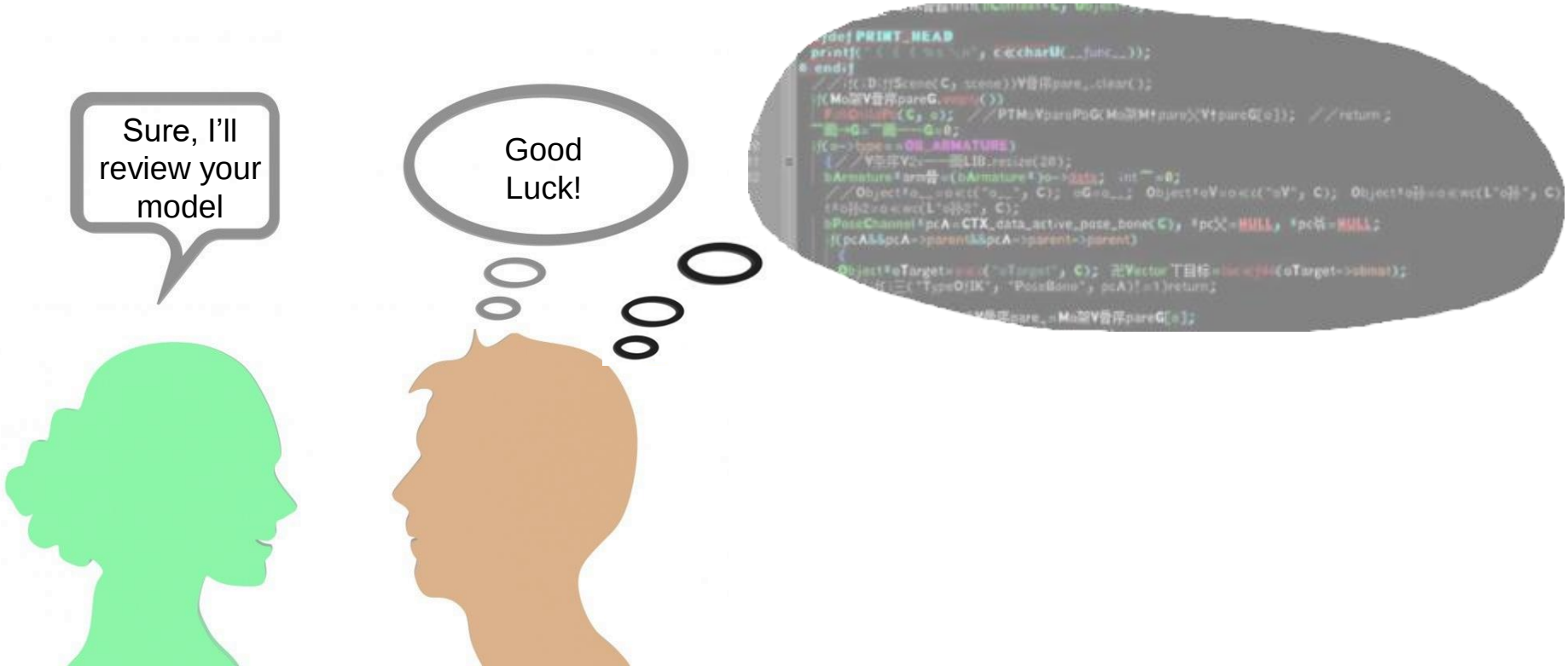
assertHE: an R package to improve quality assurance of health economic models

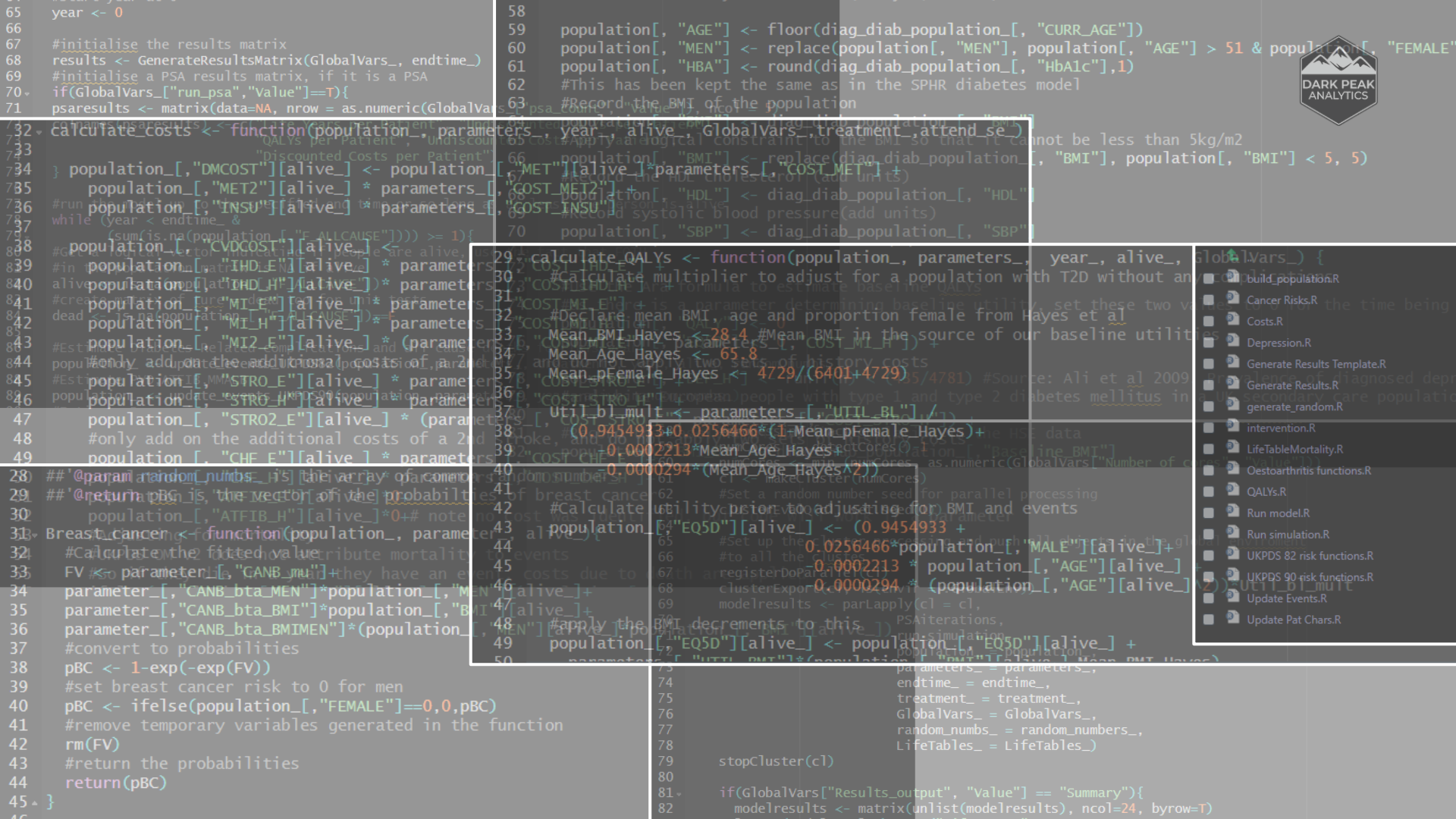
Smith et al. assertHE: an R package to improve quality assurance of health economic models. 2024. (https://github.com/dark-peak-analytics/assertHE)

Background & Motivation

Poll

Who is currently building health economic models in R?
Who is building models as a set of functions?
Who is building models as a package?
Who is writing unit tests for functions?
Who is assessing coverage of the unit tests?


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

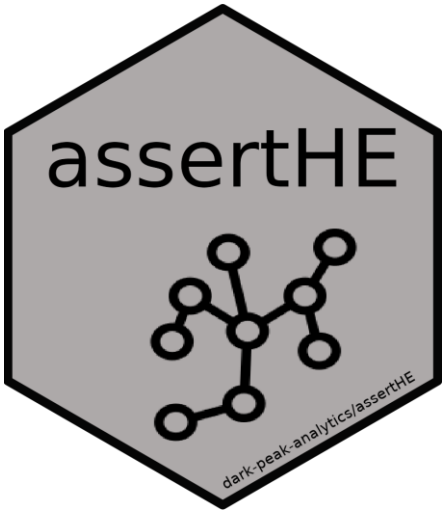
The software

assertHE R package

Aim: *to 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

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

library(assertHE)
```

A: visualise network of functions

B: insert checks for common errors into the code

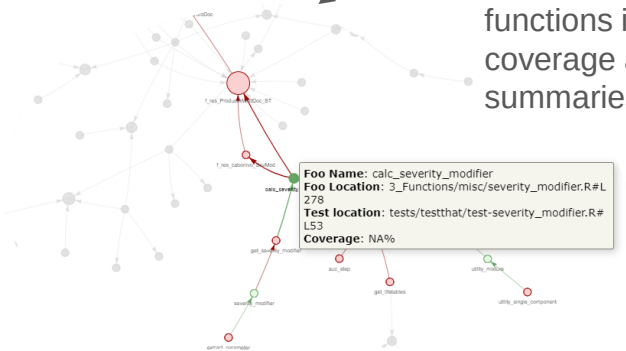
```r
check_trans_prob_array(a_P = a_P,
                       stop_if_not = T)
```

Flags if there are errors or potential problems.

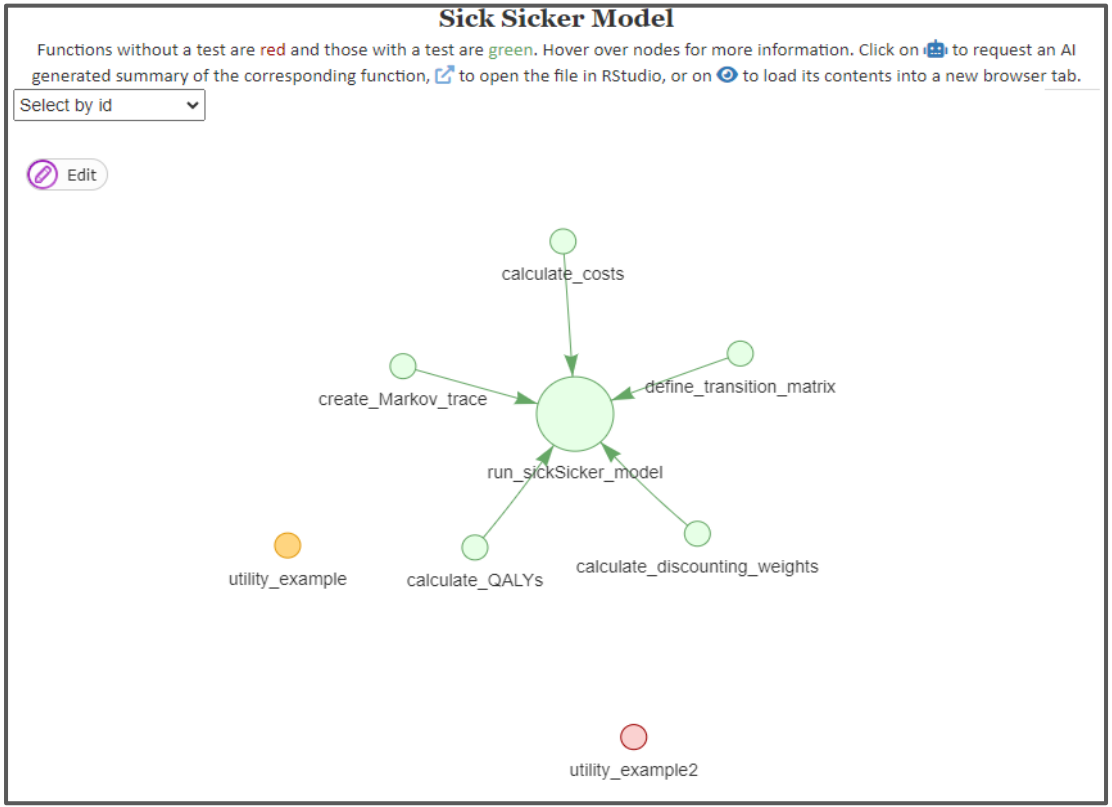
```
# Warning message:
# In check_array_rows_balanced(a_P, stop_if_not = stop_if_not) :
#   Not valid transition probabilities
#    Transition probabilities not valid from Health States:
# 1                                      H; at cycle 1
# 2                                      H; at cycle 2
# 3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

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

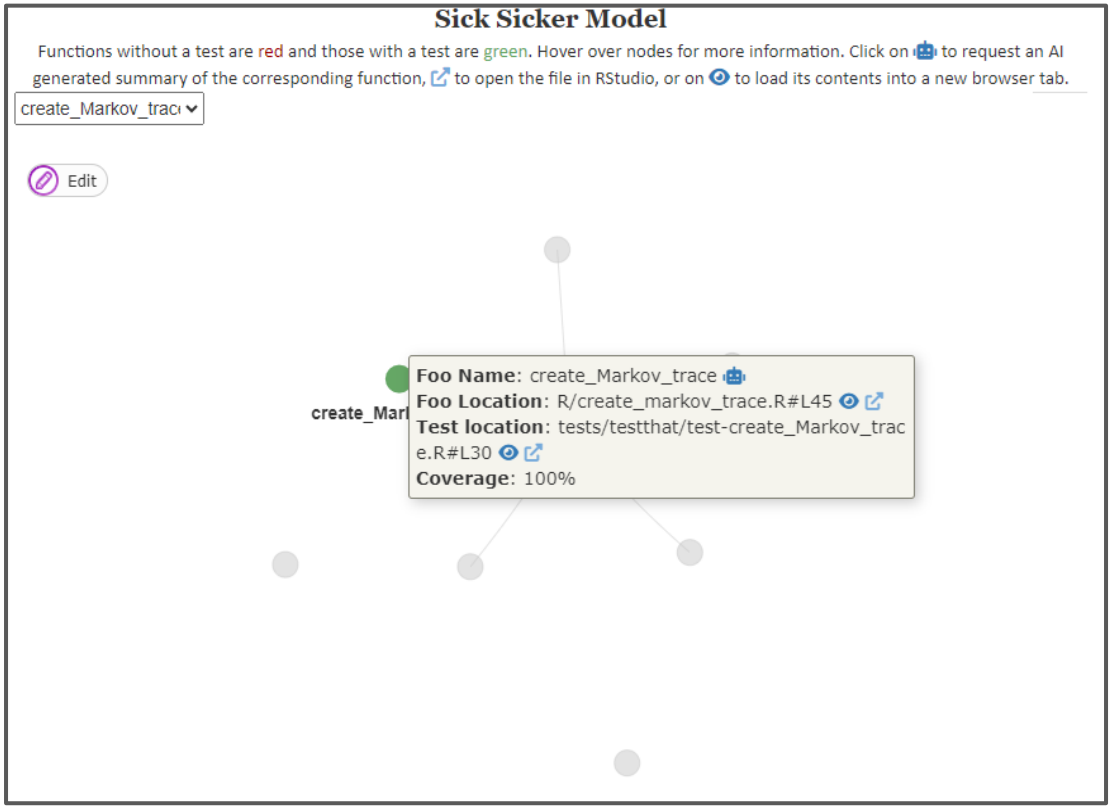
Inspect the network to understand how the model functions interact, their test coverage and get AI function summaries.



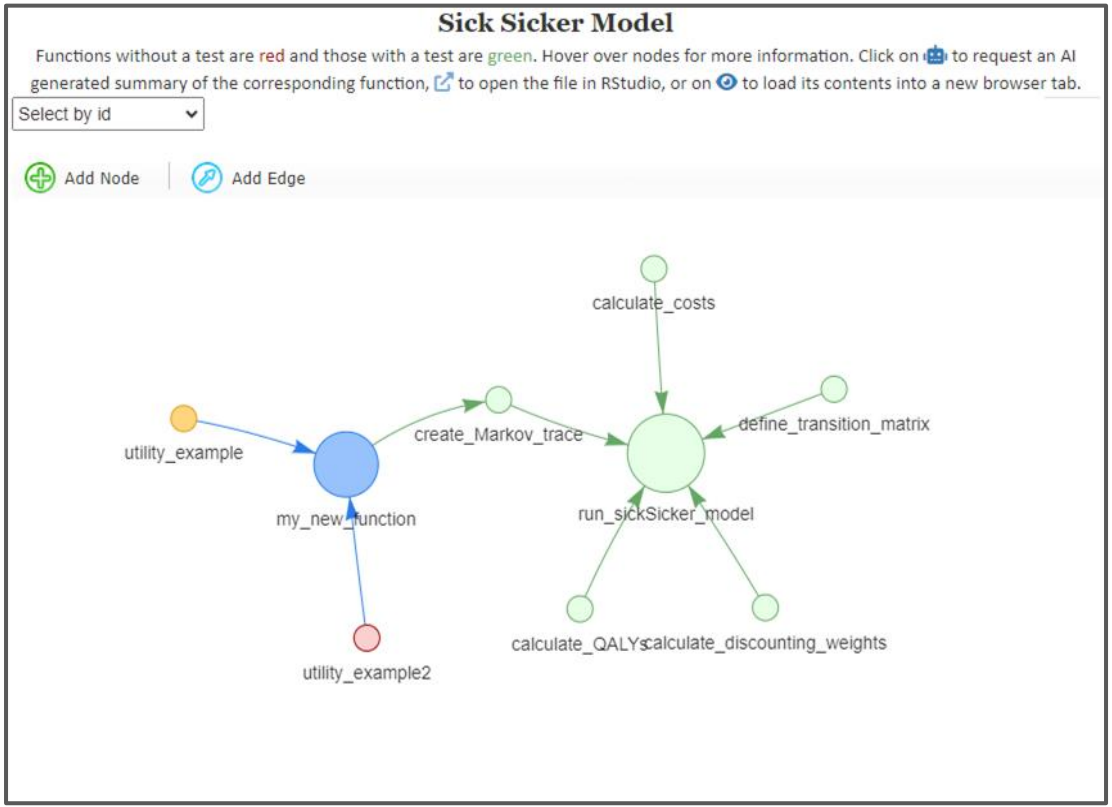
Using the *assertHE* R package



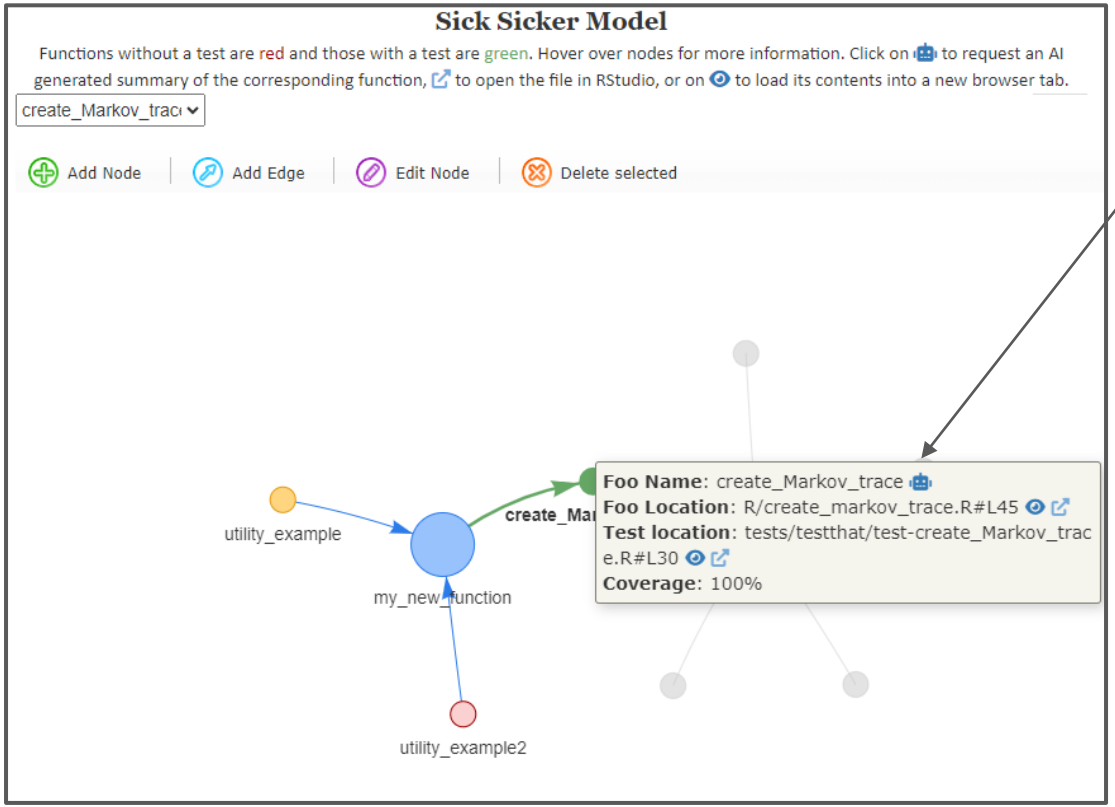
Using the *assertHE* R package



Using the *assertHE* R package

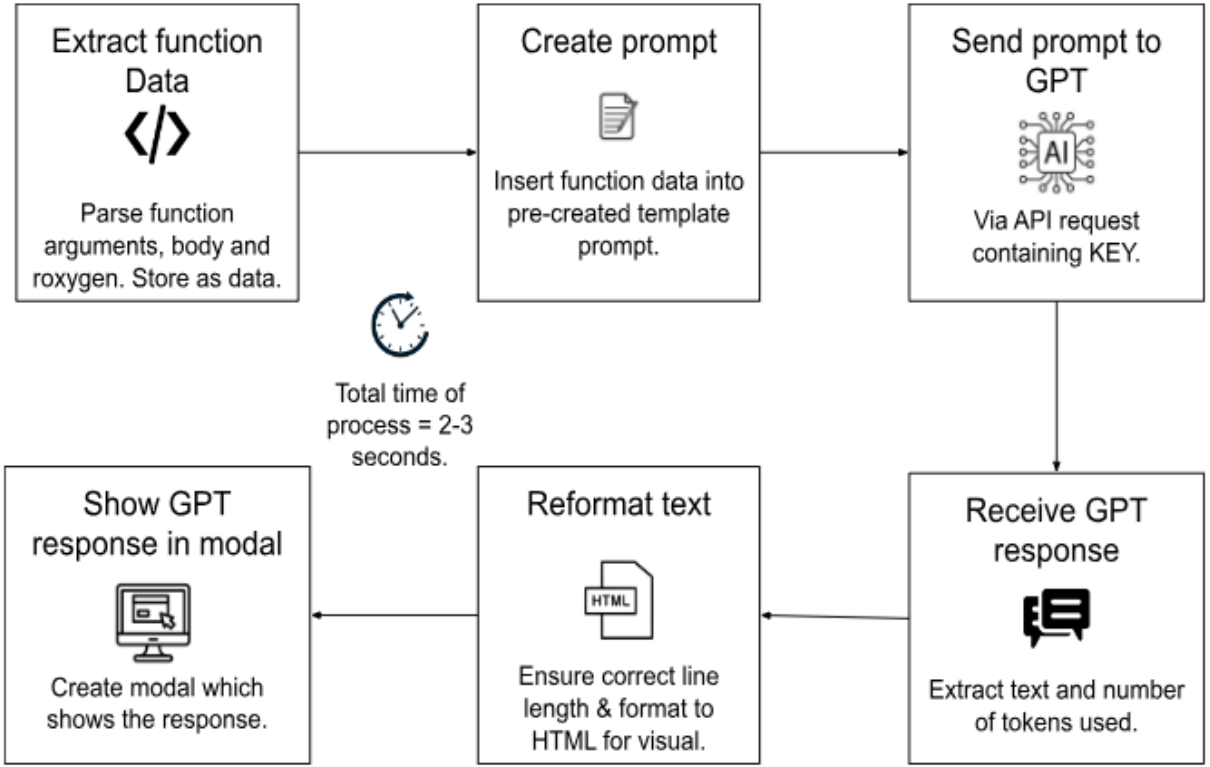


Using the *assertHE* R package

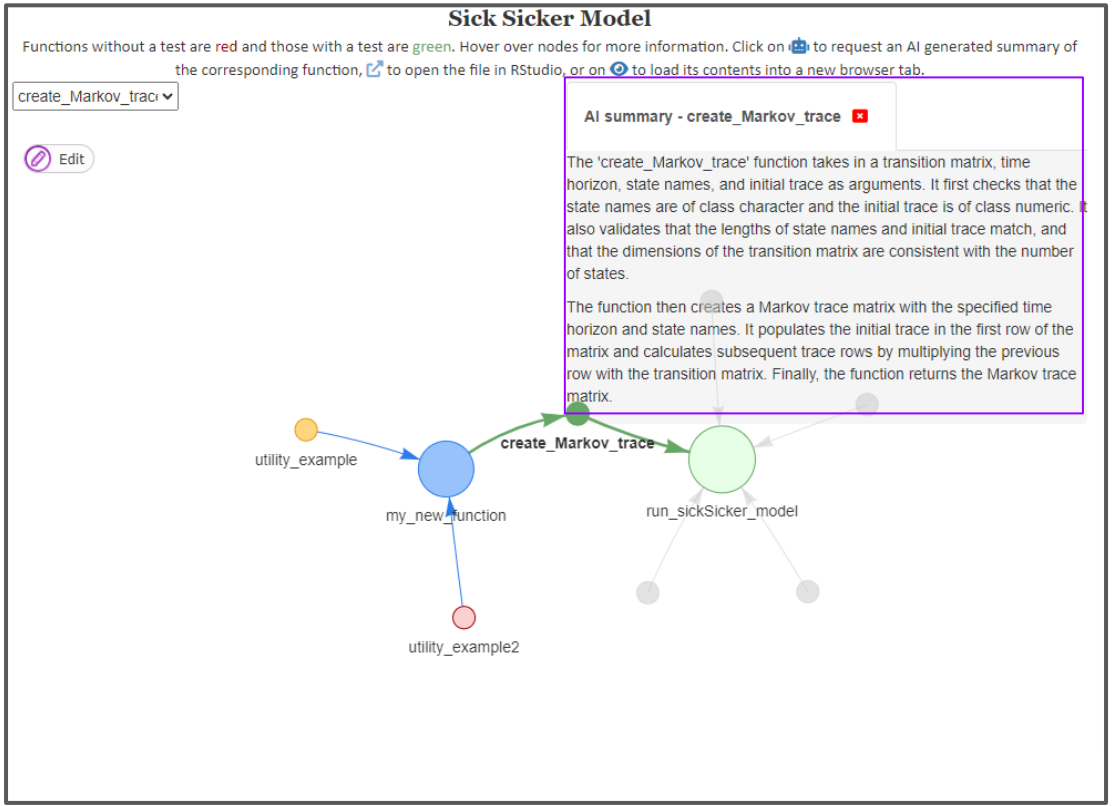


Generate LLM summary of function.

Using the *assertHE* R package



Using the *assertHE* R package



Case Studies

Case Studies

We have used the assertHE package on several models as test cases:

- NICE RCC Model
- sicksickerPack teaching model contained in a package.
- cdx2cea as described in Alarid-Escudero et al. 2022
- DOACs-AF-Economic-model developed by Bristol University
- The CGD AMR Cost model - in press.
- Embedding Economics Analysis Diabetes Microsimulation model described in (in press).

Others have used assertHE on their own models that are not in the public domain. We welcome this. Please get in contact if you have any issues or suggestions for improvements.

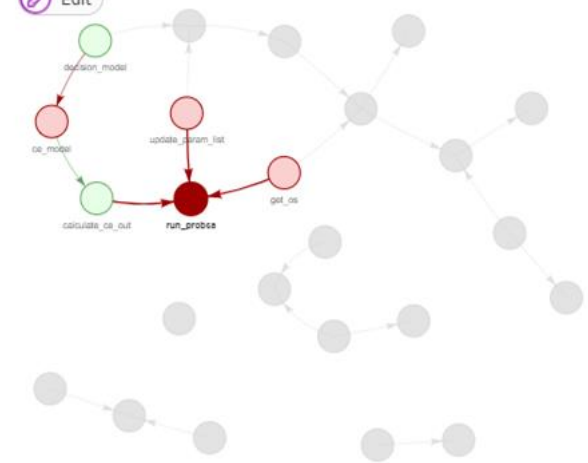
Case Study

Function Network

Functions without a test are red and those with a test are green. Hover over nodes for more information. Click on to request an AI generated summary of the corresponding function, to open the file in RStudio, or on to load its contents into a new browser tab.

run_probsa

Edit



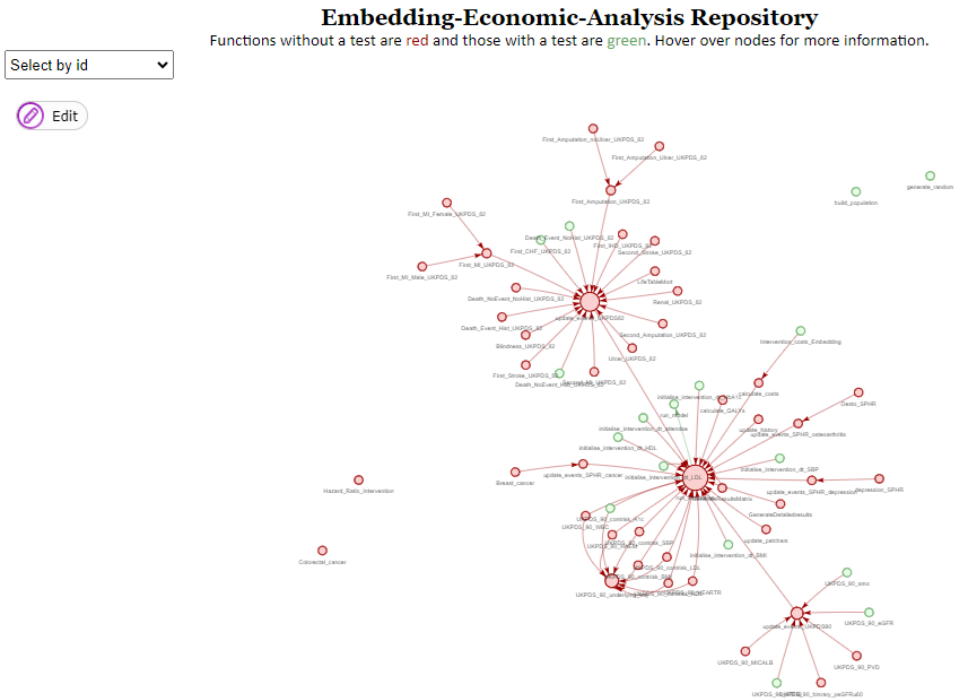
AI summary - run_probsa

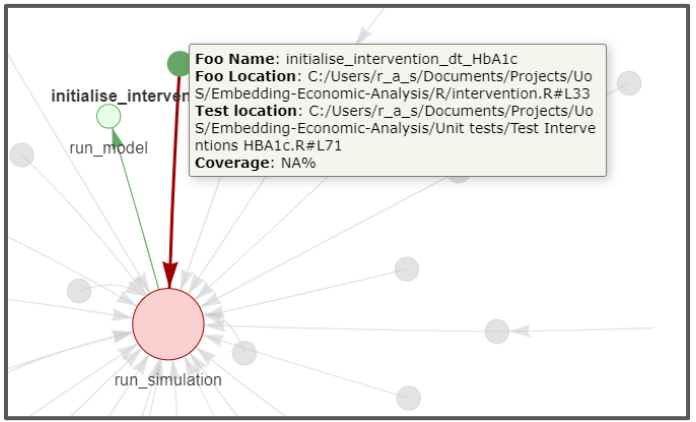
The 'run_probsa' function runs probabilistic sensitivity analysis (PSA) on a given input dataset. If the 'parallel' argument is set to TRUE, the function parallelizes the PSA process using multiple cores based on the operating system. It then calculates costs and effects for each simulation, aggregates the results, and returns them in separate data frames.

If the 'parallel' argument is set to FALSE, the function runs the PSA simulations in series. It iterates through each simulation, updates parameters, calculates costs and effects, and prints the progress. Finally, it aggregates the results and returns them in separate data frames. The function returns a list containing the costs and effects data frames.

```

ScienceDirect

Economic Evaluation

**CDX2 Biomarker Testing and Adjuvant Therapy for Stage II Colon Cancer: An Exploratory Cost-Effectiveness Analysis**

Fernando Alarid-Escudero, PhD, Deborah Schrag, MD, MPH, Karen M. Kuntz, ScD

ABSTRACT

Introduction

https://github.com/feralaes/cdx2cea
```

Case Study: Embedding Economic Analysis

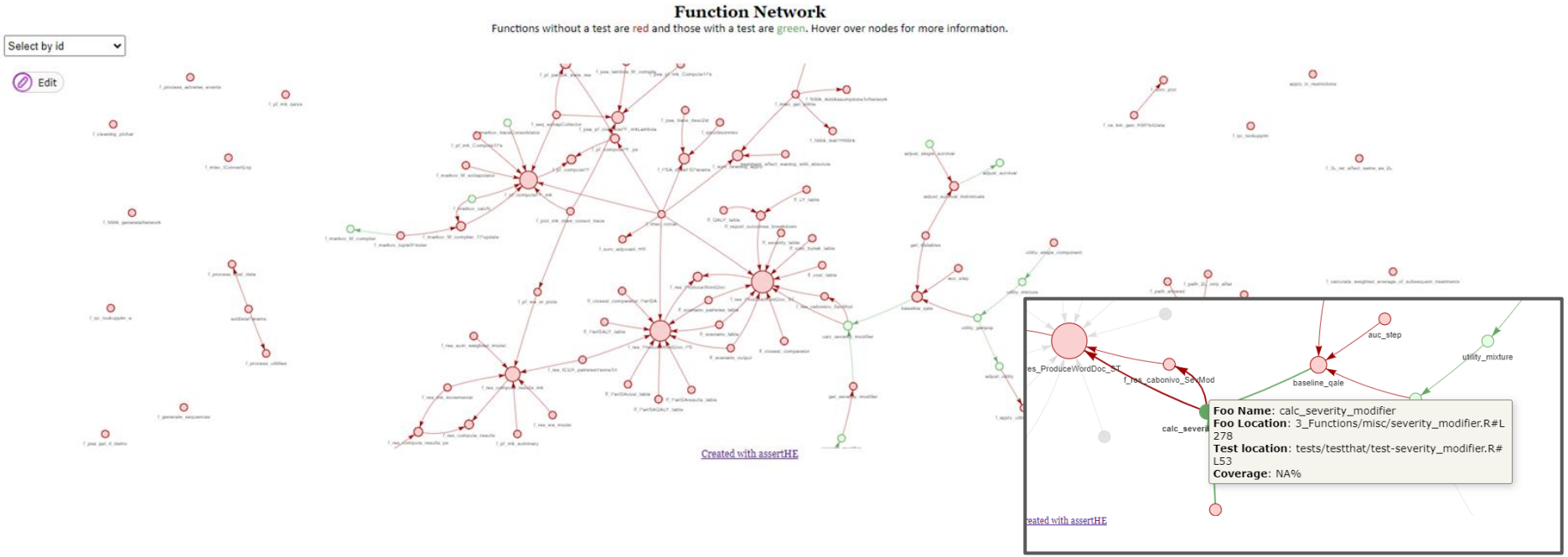




Created with assertHE

https://github.com/DanPollardSheff/Embedding-Economic-Analysis

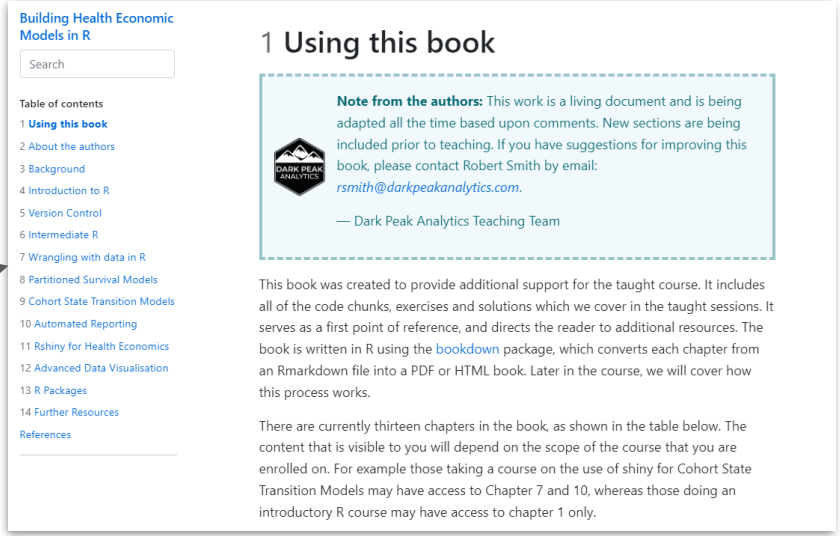
Case Study: NICE RCC Pilot



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

Next steps

1. Welcome contributions
    a. Testing the software on your models
    b. Suggesting improvements (see contribution page on GitHub)
2. Future development:
    a. LLM Chatbot integration (using DPA teaching material to fine-tune).
    b. Language selection (in progress)
3. Open access publication + CRAN submission (Summer 24)



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

Open Access Publication

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

Wellcome Open Research

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Howard Thom (University of Bristol)
Nathan Green (University College London)
Felicity Lamrock (Queens University Belfast)
Brett McQueen (University of Colorado at Denver)
Marina Richardson (Institute for Clinical and Economic Review)
Mohamed El Alili (Zorginstituut Nederland)
Xavier Pouwels (University of Twente).

March 2023

Abstract

Background: Health economic evaluation models are increasingly used to inform decisions about the allocation of health care resources. Ensuring the robustness, reliability, and reproducibility of these models is critical. Currently, quality assurance is conducted by experts assessing the different components of the model manually in isolation and in combination. However, this is resource intensive. Understanding how the different components of the model fit together is time consuming, and testing each part of the model is sometimes not feasible under the timescales provided to reviewers. To aid in this, we propose the *assertHE* R package.

Methods:

The open source *assertHE* package provides testing functionality for modellers and reviewers of health economic models. It provides a series of common checks, which can be integrated into the model development workflow to reduce the probability of common errors. It also provides a suite of functions which allow users to better understand the network of algorithms (functions) contained in the model, where they are defined, if (and where) they are tested, and the test coverage of those that have.

Results: We applied the *assertHE* package to two health economic models, showing how to include the check functions within the model code and showing how to visualise a network of functions, see the test coverage, and obtain a Generative Pretrained Transformer (GPT) Large Language Model (LLM) generated summary of any function in the codebase. We have worked with collaborators from industry, regulators and academia to develop the package to be applicable to the widest possible range of models, making adaptations to the source code based upon feedback.

Conclusions: The assertHE R software package offers a toolkit for health economists building and reviewing models, facilitating a more robust and efficient quality assurance process. We hope this will ultimately improve the quality, transparency and efficiency of the health economic evaluation process for models built in R.

Key Words:

R, Health Economics, Unit Testing, Model Validation

https://drive.google.com/file/d/1ZR0zMZjiEERdzoQM49Pm2LXtOSe4agMi/view?usp=sharing

assertHE:
HTA R model review

R-HTA 24 | Robert Smith & Tom Ward | June 2024

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

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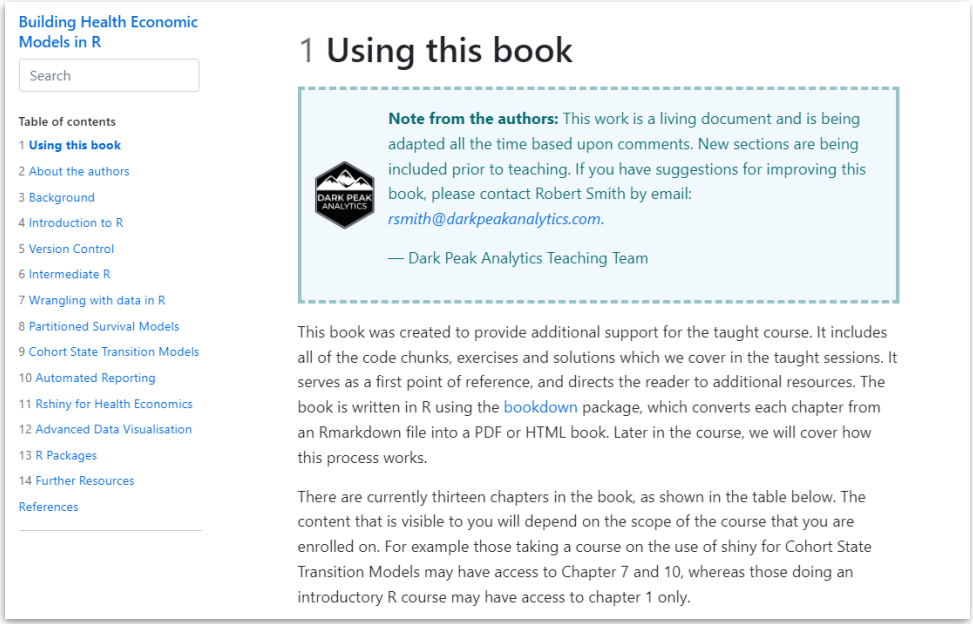
Additional resources

Book topics

We run courses on several topics relating to building health economic models in R.

- Introduction to R
- Version Control
- Intermediate R
- Wrangling with data in R
- Partitioned Survival Models
- State Transition Models
- Efficient Microsimulation in R
- Automated Reporting
- RShiny for Health Economics
- Advanced Data visualisation
- R packages
- Reviewing Health Economic Models in R



[Bespoke training courses]

Making Health Economic Models Shiny: Sept 24

Dates

The online course sessions are held on four consecutive Thursdays in September and October 2024:

1. Thursday, 12 September 2024
2. Thursday, 19 September 2024
3. Thursday, 26 September 2024
4. Thursday, 03 October 2024

Each session runs from:

13:00 - 16:00 GMT (London time)
08:00 - 11:00 EST (New York time)
17:00 - 20:00 GST (Dubai time)

PLUS: optional drop-in code clinics are held on Tuesdays:

1. Tuesday, 17 September 2024
2. Tuesday, 24 September 2024
3. Tuesday, 01 October 2024
4. Tuesday, 08 October 2024

Each code clinic runs from:

13:00 - 14:30 GMT (London time)
08:00 - 09:30 EST (New York time)
17:00 - 18:30 GST (Dubai time)

https://www.courses.darkpeakanalytics.com/