



# R you ready for Shiny Health Economics?

Robert Smith[1,2]

1) School of Health and Related Research, University of Sheffield, UK.
2) Dark Peak Analytics Ltd, Sheffield, UK

# Background

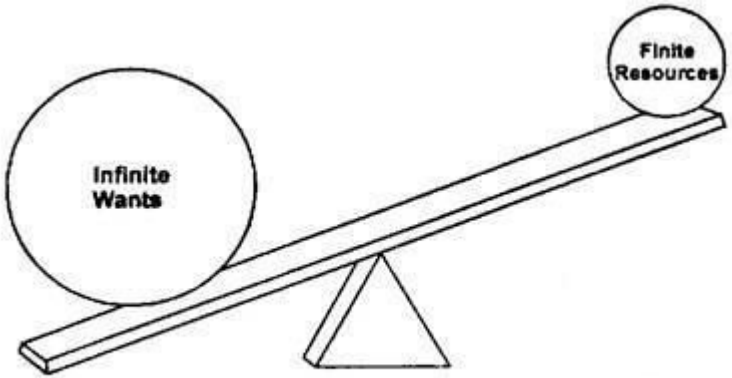


**Fig. 1.1:** The economic problem: finite resources and infinite wants

# Background

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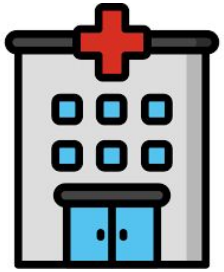
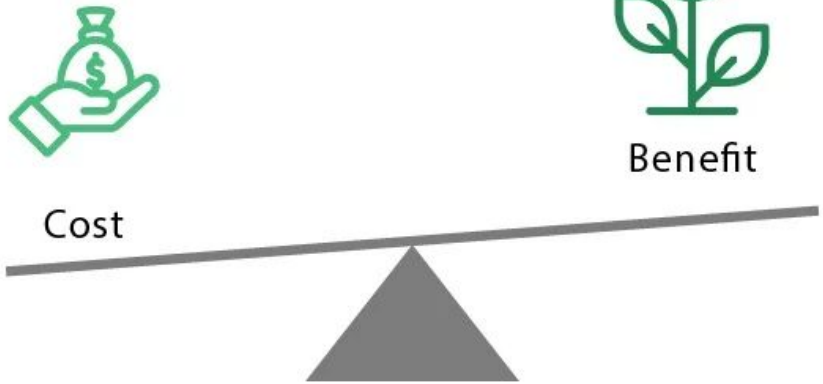
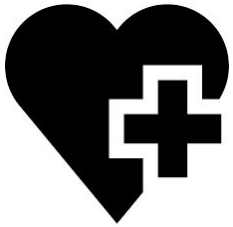
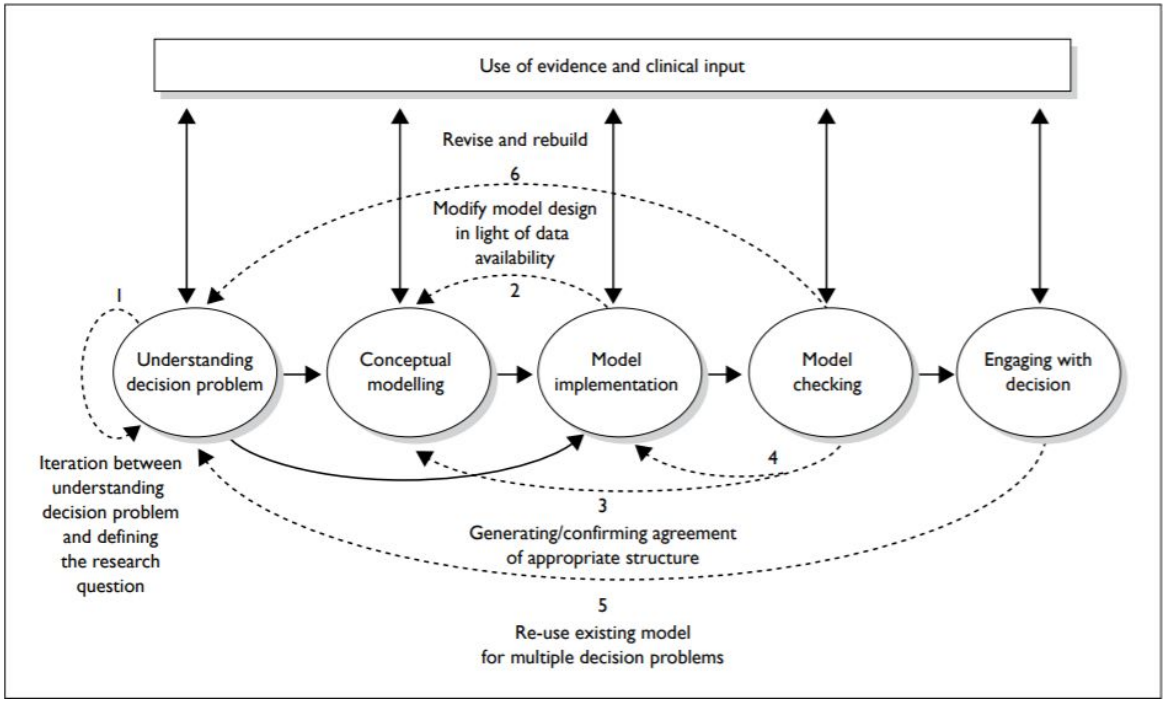




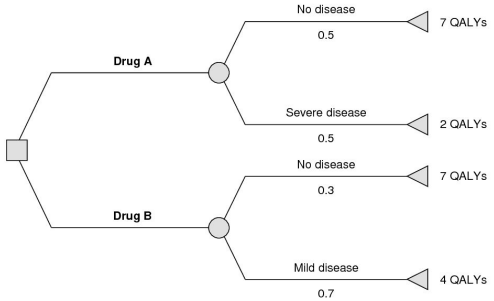
# Modelling framework



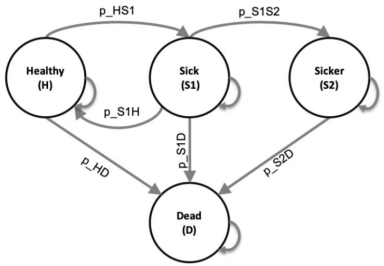

Source: Chilcott et al., 2010

# Software Choice

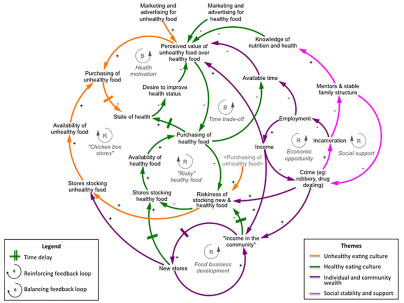
## Decision Tree




## Cohort Model (STM/PSM)



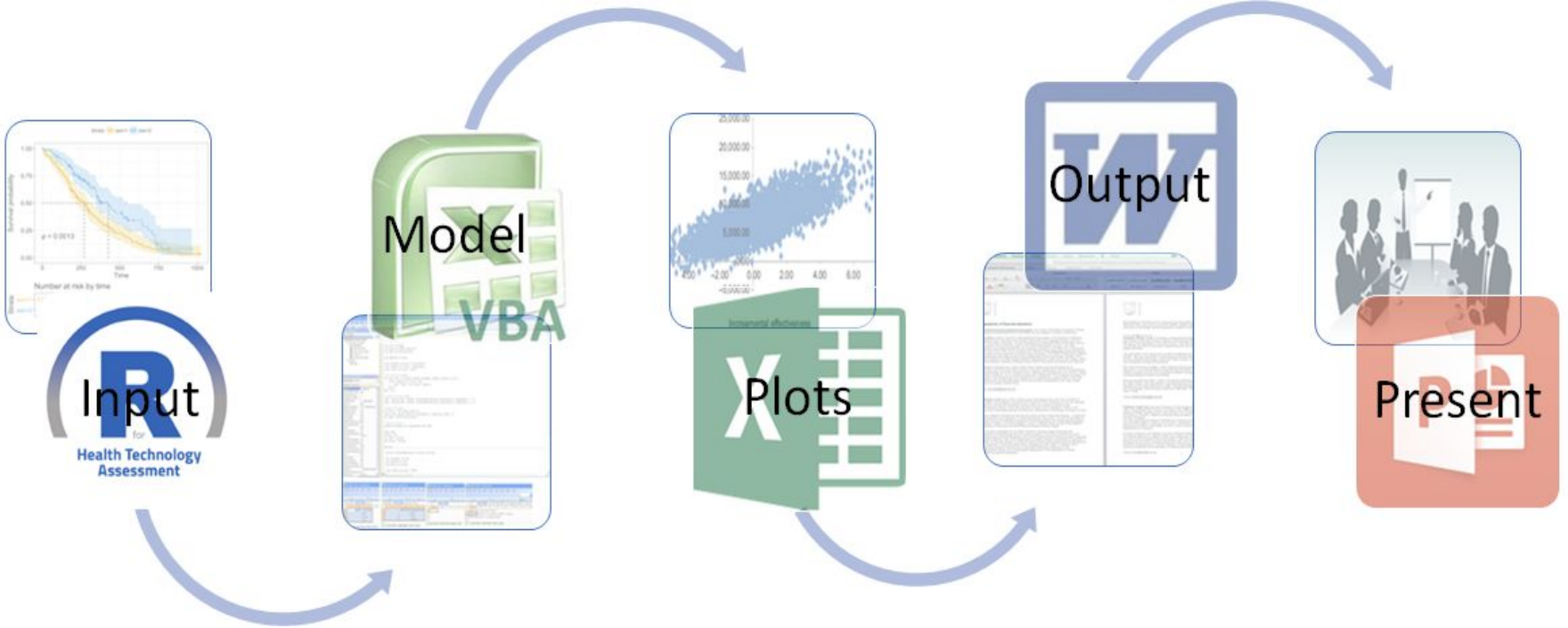

## Individual Level



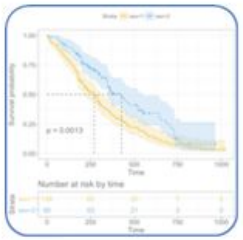


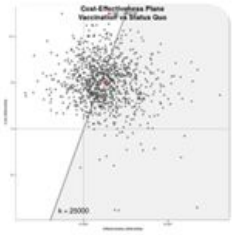
Complexity, computational burden, data...

# Current Process

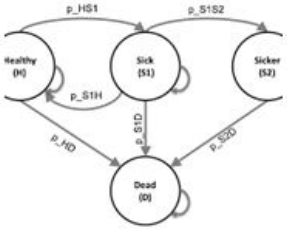


# Future Process











# Future Process: Benefits

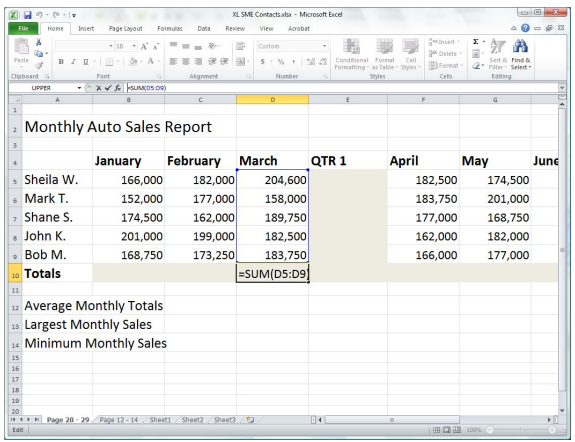

1. One click update + transcription error reduction.
2. Speed of model creation (hence R not C++, time is money)!
3. Computational power (Rcpp) - VOI, analysis.
4. Code/data separation, testing independent of data.
5. Transparency - especially where publicly funded.
6. Reach & replication, one worldwide model on remote server.
7. Stakeholder engagement - Shiny + expert elicitation.

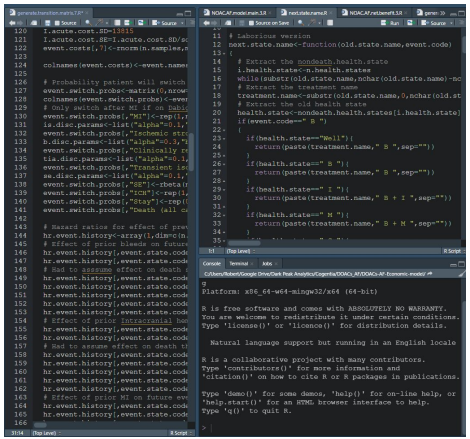

# Future Process: Limitations


1. Learning curve (time is money).
2. Perception of R models as being blackbox - hard to review.
3. Danger of low package quality.

4. Until 2016+ - lack of easy to build graphical user interface.

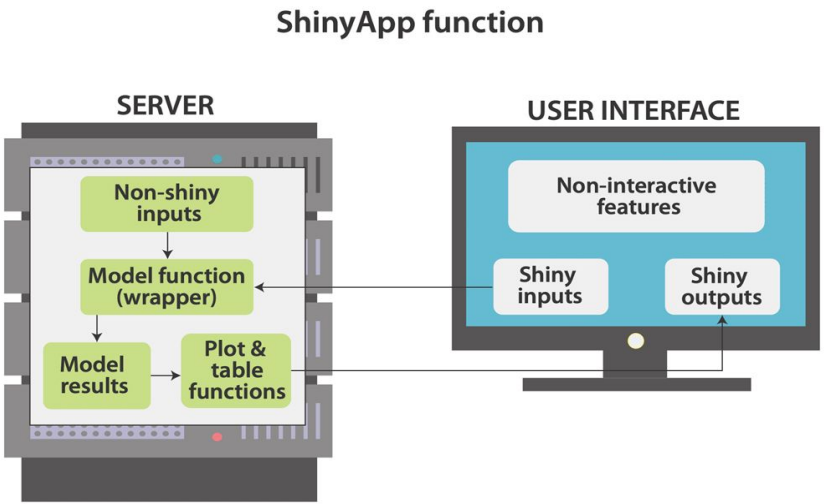
# Graphical User Interface

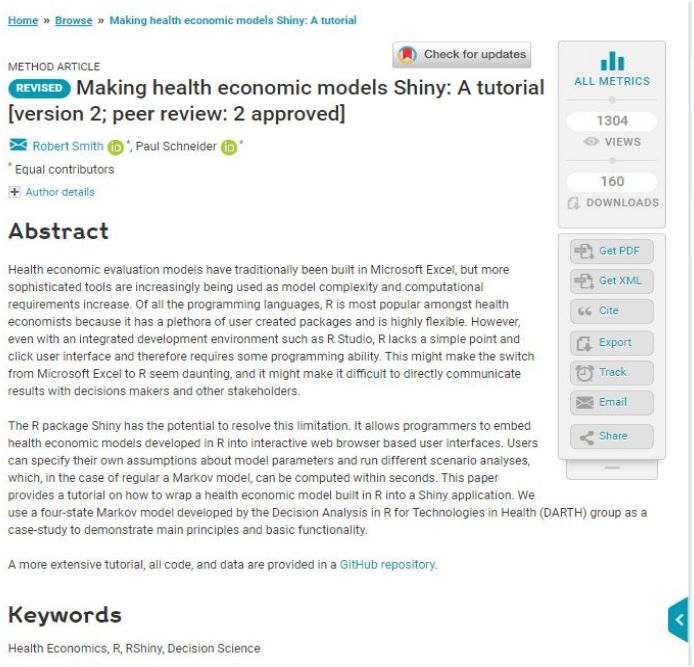


"... that code looks scary" (Anon, 2020)

# Open-source tutorial



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METHOD ARTICLE

**REVISED** **Making health economic models Shiny: A tutorial [version 2; peer review: 2 approved]**

Robert Smith, Paul Schneider

Equal contributors

Author details

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## Abstract

Health economic evaluation models have traditionally been built in Microsoft Excel, but more sophisticated tools are increasingly being used as model complexity and computational requirements increase. Of all the programming languages, R is most popular amongst health economists because it has a plethora of user created packages and is highly flexible. However, even with an integrated development environment such as R Studio, R lacks a simple point and click user interface and therefore requires some programming ability. This might make the switch from Microsoft Excel to R seem daunting, and it might make it difficult to directly communicate results with decisions makers and other stakeholders.

The R package Shiny has the potential to resolve this limitation. It allows programmers to embed health economic models developed in R into interactive web browser based user interfaces. Users can specify their own assumptions about model parameters and run different scenario analyses, which, in the case of regular a Markov model, can be computed within seconds. This paper provides a tutorial on how to wrap a health economic model built in R into a Shiny application. We use a four-state Markov model developed by the Decision Analysis in R for Technologies in Health (DARTH) group as a case-study to demonstrate main principles and basic functionality.

A more extensive tutorial, all code, and data are provided in a GitHub repository.

## Keywords

Health Economics, R, RShiny, Decision Science

Paper: https://wellcomeopenresearch.org/articles/5-69
Code: https://github.com/RobertASmith/healthecon_shiny

# Open-source tutorial

Inputs → Function → Outputs

| Parameters | | |
|---|---|---|
| c_s1 | cost1 | 3 |
| c_s2 | cost2 | 5 |
| c_H | cost3 | 6 |
| dr | Dis_rate | 0.035 |
| n_sim | No. psa | 1000 |

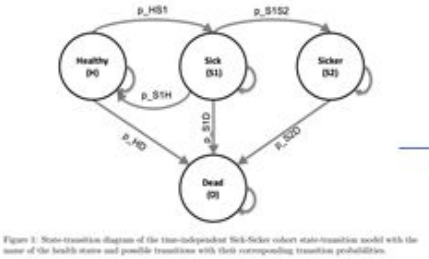
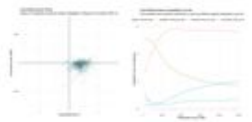



Figure 1: State-transition diagram of the time-independent Sick-Sicker cohort state-transition model with the name of the health states and possible transitions with their corresponding transition probabilities.

Results Table

| Option | QALYs | Costs | Inc.QALYs | Inc.Costs | ICER |
|---|---|---|---|---|---|
| Treatment | 18.56 | 101106.37 | 0.63 | 1422.23 | 2320.60 |
| No Treatment | 17.93 | 99684.14 | N/A | N/A | N/A |



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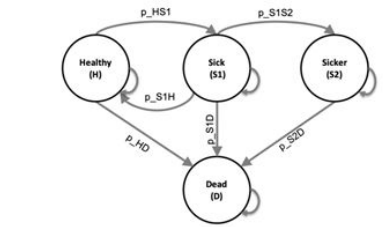


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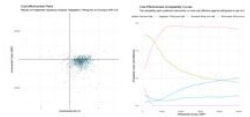



# Open-source tutorial

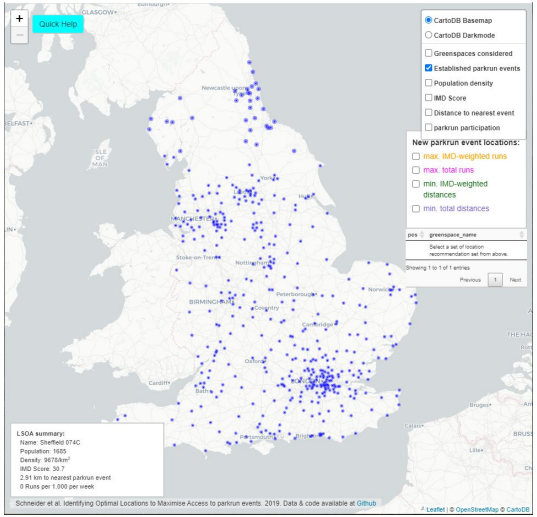

Code: https://github.com/RobertASmith/healthecon_shiny/tree/master/Tutorial
Tutorial: https://r-hta.org/tutorial/markov_models_shiny/
App: https://robertasmith.shinyapps.io/sick_sicker/

# Example: WHO FGM



https://srhr.org/fgmcost/cost-calculator/

# Example: parkrun

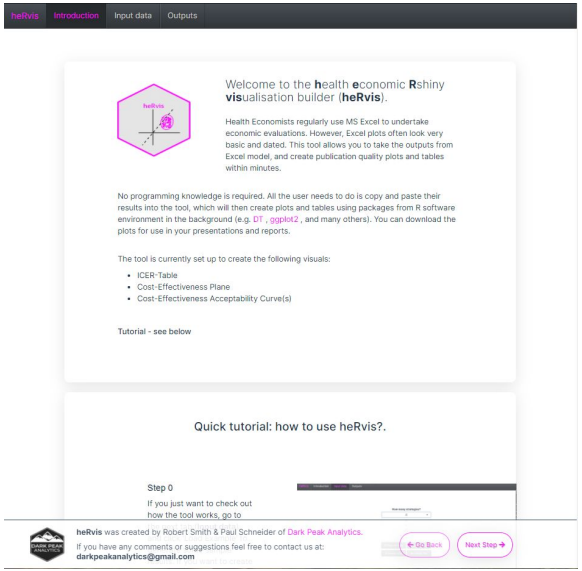


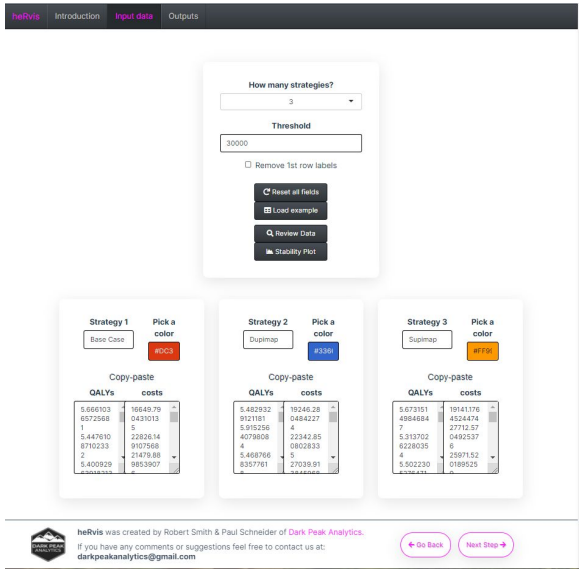


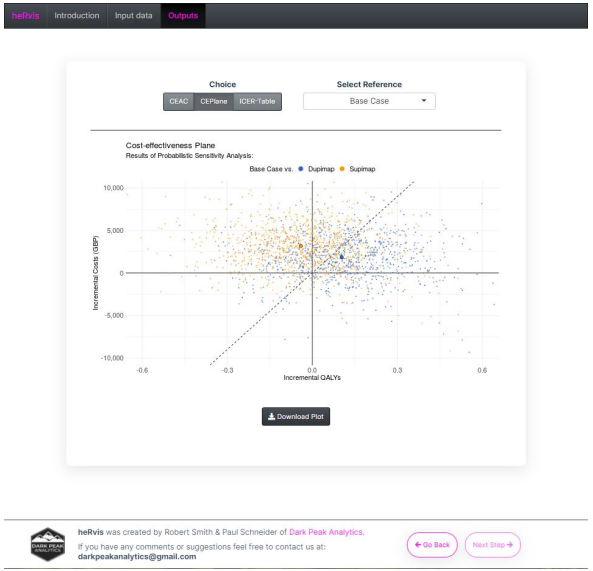
Paper: https://www.sciencedirect.com/science/article/pii/S0033350620304066
Code: https://github.com/bitowaqr/iolmap_analysis
App: http://iol-map.shef.ac.uk/

Paper: https://wellcomeopenresearch.org/articles/5-9
Code: https://github.com/ScHARR-PHEDS/DoPE_Public

# Example: HTA



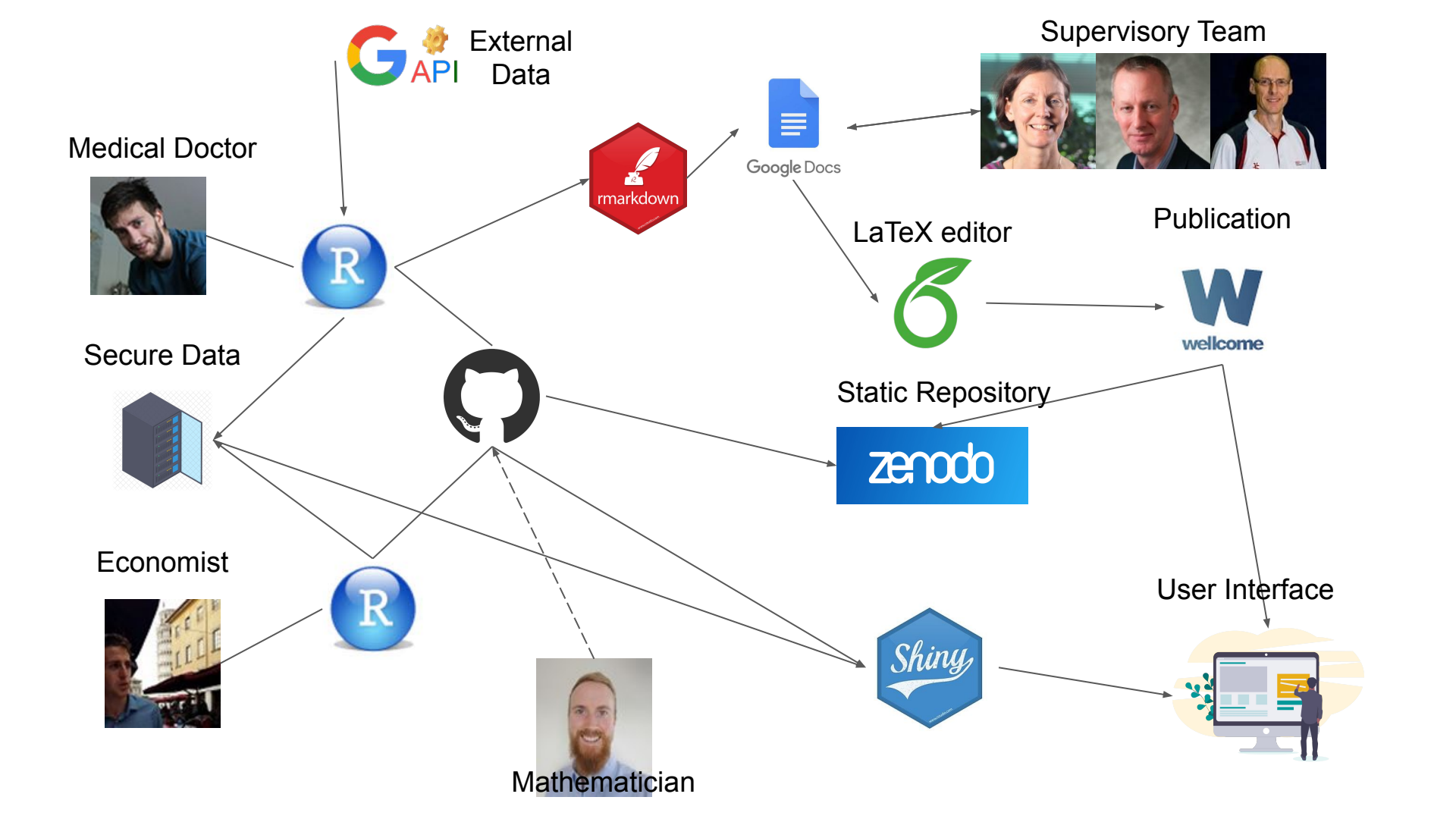




https://darkpeakanalytics.shinyapps.io/heRvis/

# Thanks from Sheffield

Git: https://github.com/RobertASmith
Web: https://www.darkpeakanalytics.com/
Email: rasmith3@sheffield.ac.uk
LinkedIn: https://www.linkedin.com/in/robert-smith-53b28438/

# Modelling Transparency & Efficiency


External Data
API
Supervisory Team
Medical Doctor
rmarkdown
Google Docs
LaTeX editor
Publication
wellcome
Secure Data
Static Repository
zenodo
Economist
User Interface
Shiny
Mathematician

# Background

# Background






World Health
Organization

NICE
National Institute for
Health and Care Excellence

# Model Types

| | | | A | B | C | D |
|---|---|---|---|---|---|---|
| | | | Cohort/Aggregate Level/Counts | | Individual Level | |
| | | | Expected value, Continuous state, Deterministic | Markovian, Discrete State, Stochastic | Markovian, Discrete State, Individuals | Non-Markovian, Discrete-State, Individuals |
| 1 | No Interaction Allowed | Untimed | Decision Tree Rollback | Simulated Decision Tree (SDT) | Individual Sampling Model (ISM): Simulated Patient-Level Decision Tree (SPLDT) | |
| 2 | No Interaction Allowed | Timed | Markov Model (Evaluated Deterministically) | Simulated Markov Model (SMM) | Individual Sampling Model (ISM): Simulated Patient-Level Markov Model (SPLMM) (variations as in quadrant below for patient level models with interaction) | |
| 3 | Interaction Allowed | Discrete Time | System Dynamics (Finite Difference Equations, FDE) | Discrete Time Markov Chain Model (DTMC) | Discrete-Time Individual Event History Model (DT, IEH) | Discrete Individual Simulation (DT, DES) |
| 4 | Interaction Allowed | Continuous Time | System Dynamics (Ordinary Differential Equations, ODE) | Continuous Time Markov Chain Model (CTMC) | Continuous Time Individual Event History Model (CT, IEH) | Discrete Event Simulation (CT, DES) |

**Brennan, A., Chick, S.E. and Davies, R., 2006. A taxonomy of model structures for economic evaluation of health technologies. *Health economics*, *15*(12), pp.1295-1310.**

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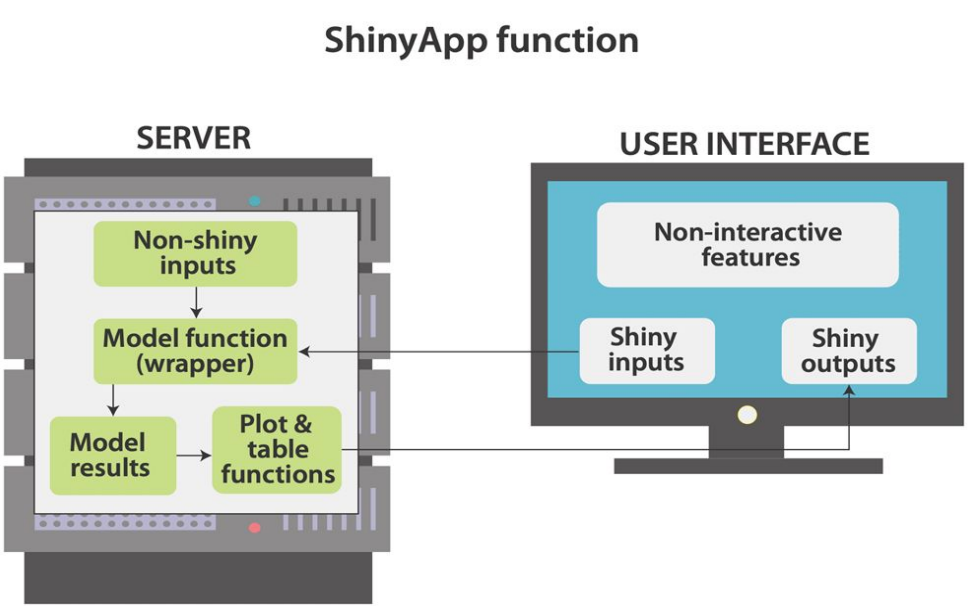


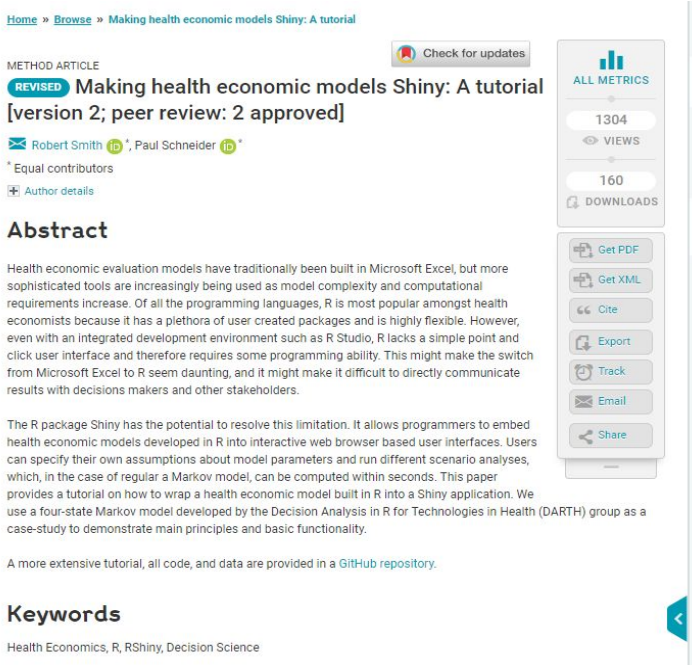

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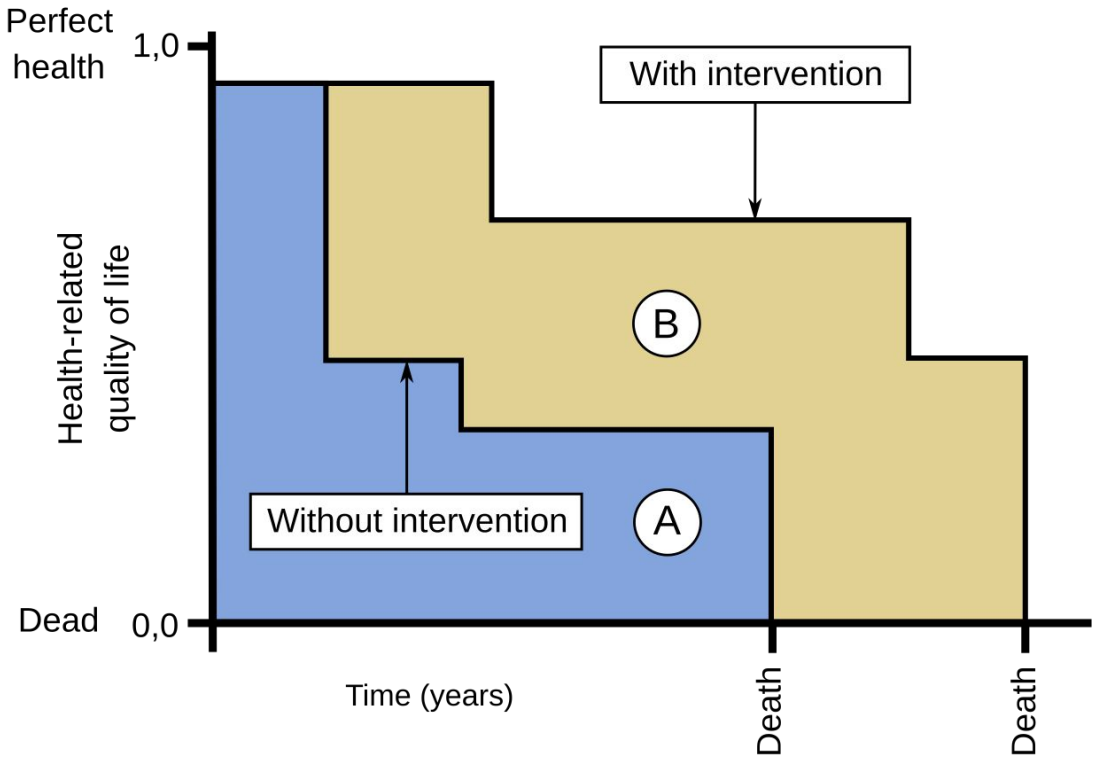
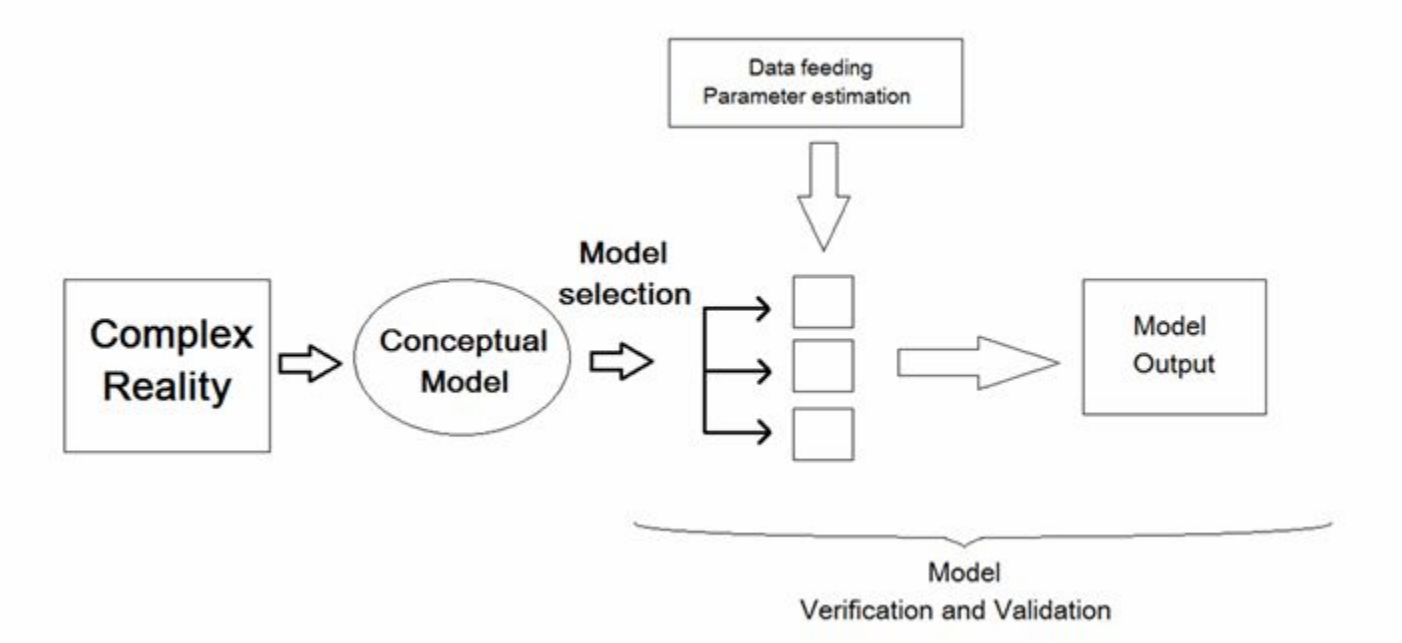

Perfect health
1,0
With intervention
Health-related quality of life
B
Without intervention
A
Dead
0,0
Time (years)
Death
Death

# Modelling framework




https://www.codeproject.com/Articles/1111093/Discrete-Event-Simulation-using-R-Hospital-Capacit