



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

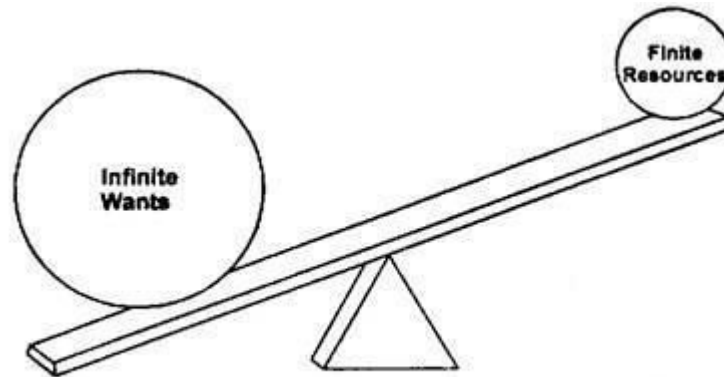


Fig. 1.1: The economic problem: finite resources and infinite wants

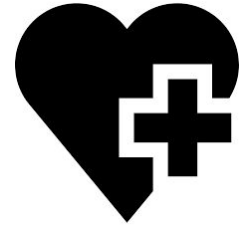
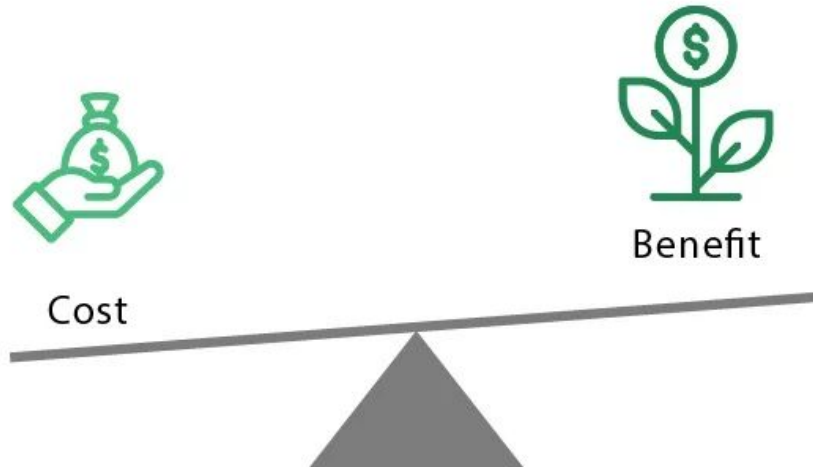
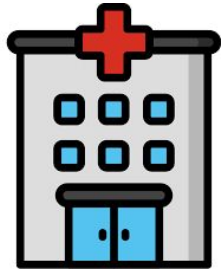


Background



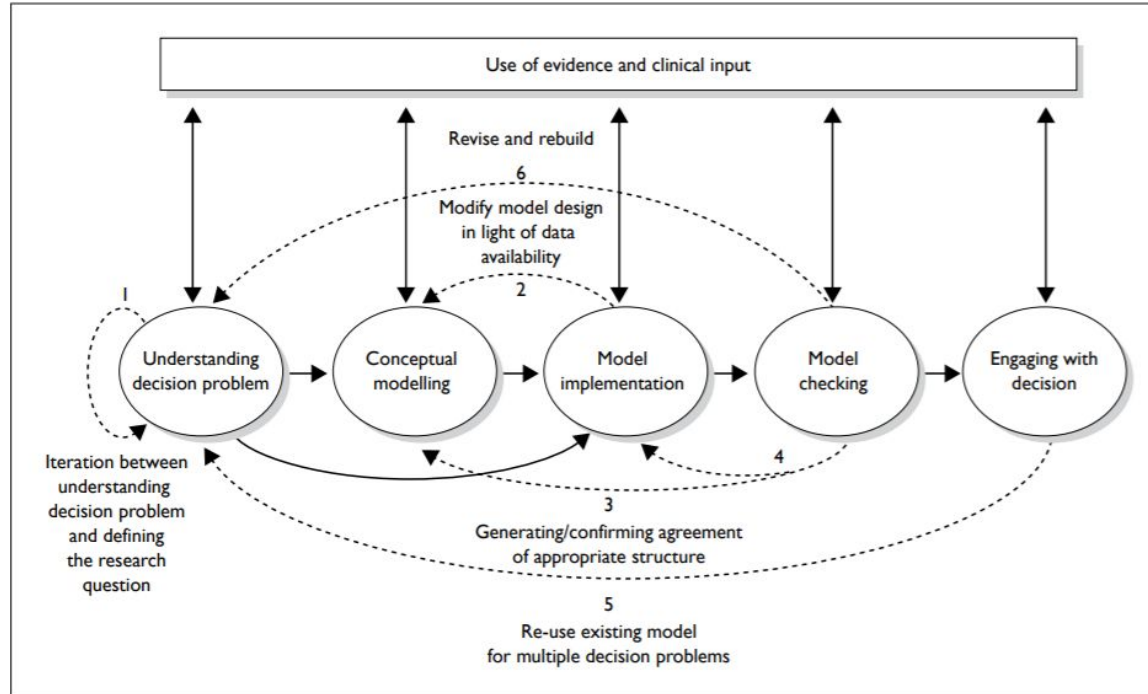


Background





Modelling framework



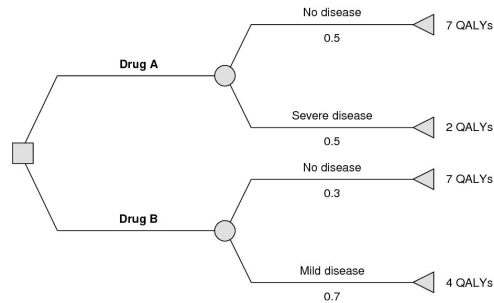
Source: Chilcott et al., 2010



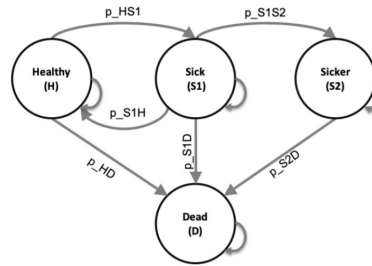
Software Choice



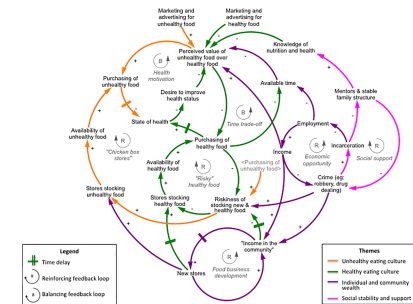
Decision Tree



Cohort Model (STM/PSM)



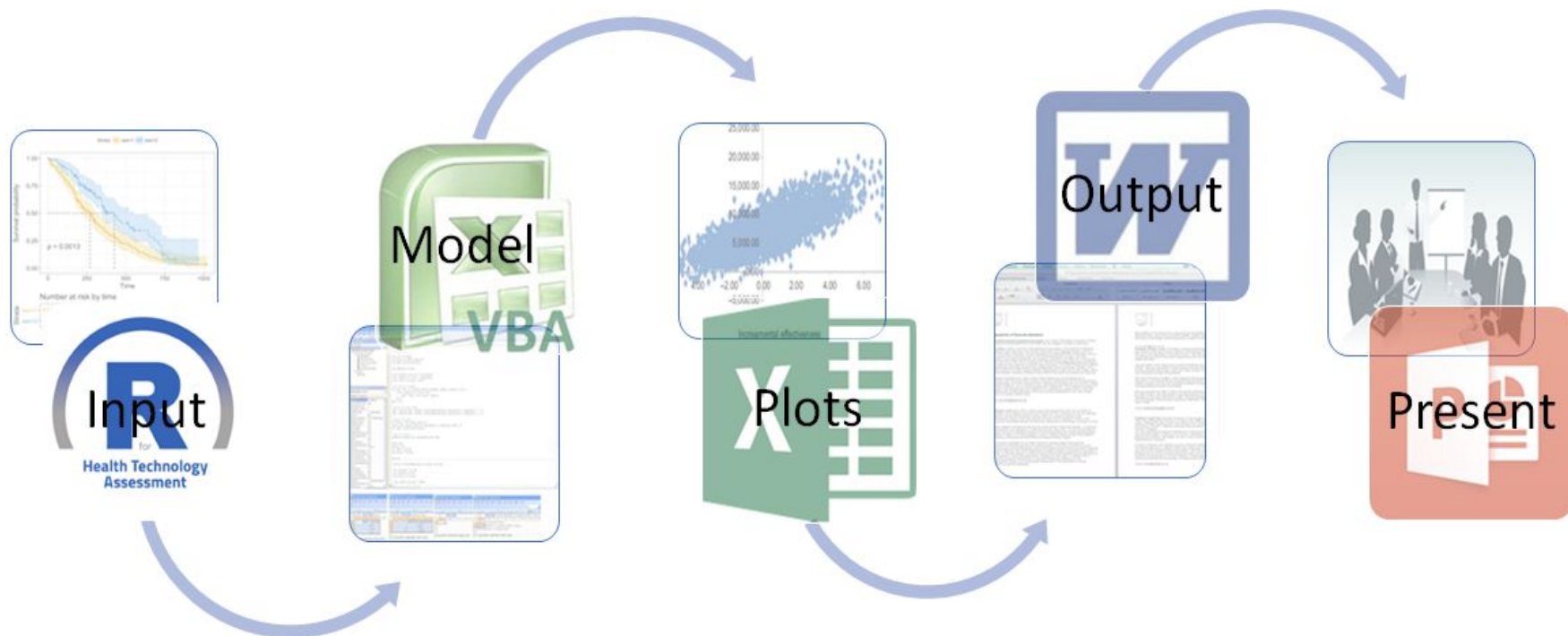
Individual Level



Complexity, computational burden, data...

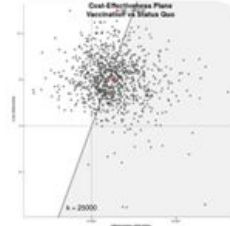
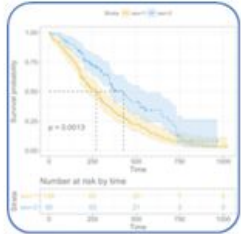


Current Process





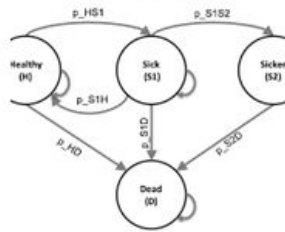
Future Process



VALUING HEALTH TECHNOLOGIES AT NET COMMENDATIONS FOR IMPROVED INCORPORATION OF TREATMENT VALUE IN HTA

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†Department of Health Economics, Royal College of Physicians, Royal College of Physicians, London, UK
‡Department of Health Economics, Royal College of Physicians, Royal College of Physicians, London, UK

1. INTRODUCTION
Healthcare systems and service providers are faced with the challenge of allocating resources to the most effective and efficient interventions. In the UK, the National Institute for Health and Care Research (NIHR) is charged with the difficult task of ensuring that the most effective and efficient interventions are funded. This is a complex task, as it requires the integration of clinical, economic, and social evidence. The purpose of this paper is to discuss the challenges of valuing health technologies at net commensurate for improved incorporation of treatment value in HTA.





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



Monthly Auto Sales Report							
	January	February	March	QTR 1	April	May	June
Sheila W.	166,000	182,000	204,600		182,500	174,500	
Mark T.	152,000	177,000	158,000		183,750	201,000	
Shane S.	174,500	162,000	189,750		177,000	168,750	
John K.	201,000	199,000	182,500		162,000	182,000	
Bob M.	168,750	173,250	183,750		166,000	177,000	
Totals			=SUM(D5:D9)				
Average Monthly Totals							
Largest Monthly Sales							
Minimum Monthly Sales							

```
120 i.state.cost<-ID1$ID1
121 i.state.cost<-ID1$state.cost.ID1
122 event.cost[i,]<-norm.in.samples.n
123
124 colnames(event.cost)<-event.name
125
126 # probability pattern will switch
127 event.switch.probs<-matrix(0,nrow
128 colnames(event.switch.probs)<-event
129 # only switch after 10 on trial
130 event.switch.probs["0"]<-rep(1/7
131 10,discrete.param="list("alpha"<-0.1,
132 event.switch.probs["1"]<-c(0.5,0.5)
133 b.discrete.param="list("alpha"<-0.5,
134 event.switch.probs["1"]<-c(0.5,0.5)
135 event.switch.probs["1"]<-c(0.5,0.5)
136 event.switch.probs["1"]<-c(0.5,0.5)
137 event.switch.probs["1"]<-c(0.5,0.5)
138 event.switch.probs["1"]<-c(0.5,0.5)
139 event.switch.probs["1"]<-c(0.5,0.5)
140 event.switch.probs["1"]<-c(0.5,0.5)
141 event.switch.probs["1"]<-c(0.5,0.5)
142
143 # hazard ratios for effect of prior
144 hr.event.history<-array(1,discrete
145 # effect of prior history on future
146 hr.event.history.event.state.code
147 hr.event.history.event.state.code
148 # had to assume effect on death
149 hr.event.history.event.state.code
150 hr.event.history.event.state.code
151 hr.event.history.event.state.code
152 hr.event.history.event.state.code
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162 hr.event.history.event.state.code
163 # effect of prior history on future
164 hr.event.history.event.state.code
165 hr.event.history.event.state.code
166
```

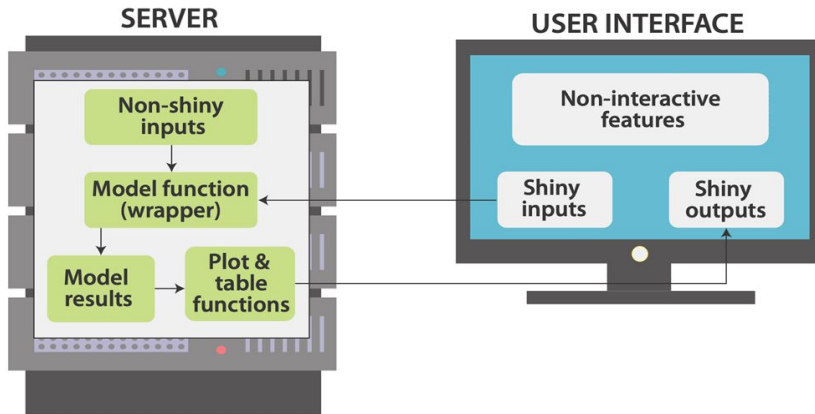
“... that code looks scary” (Anon, 2020)



Open-source tutorial



ShinyApp function



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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](#)

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

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Inputs \longrightarrow Function \longrightarrow Outputs

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

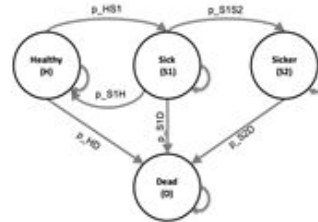
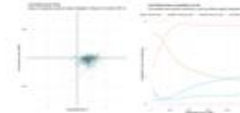


Figure 1: State-transition diagram of the two-independent Sick-Sicker cohort state-transition model with the name of the health state and possible transitions with their corresponding transition probabilities.

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



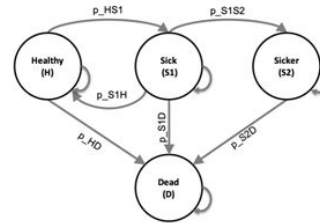


Open-source tutorial



Inputs \longrightarrow Function \longrightarrow Outputs

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c_s1	cost1	3
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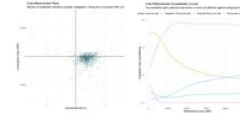


Figure 1: State-transition diagram of the time-independent Sick-Sicker cohort state-transition model with the name of the health states and possible transitions with their corresponding transition probabilities.



Treatment Cost

PSA runs

Initial age



Open-source tutorial



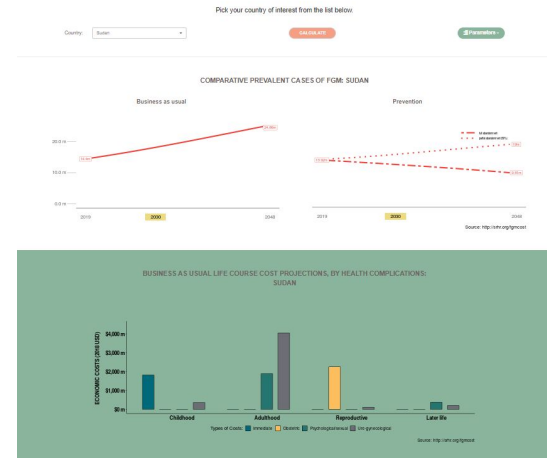
Code: https://github.com/RobertASmith/healthecon_shiny/tree/master/Tutorial

Tutorial: https://r-hta.org/tutorial/markov_models_shiny/

App: https://robertasmith.shinyapps.io/sick_sicker/



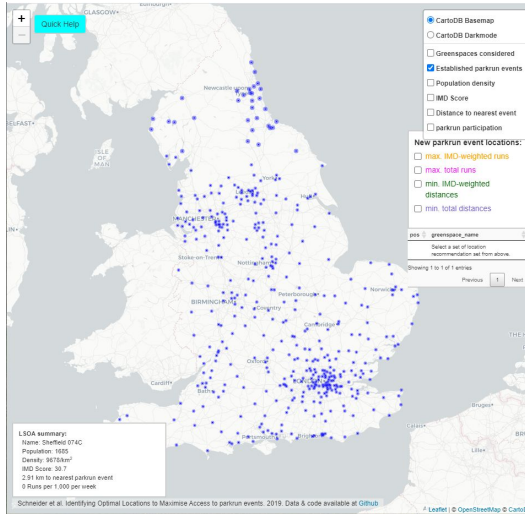
Example: WHO FGM



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



Example: parkrun



Public Health
Volume 189, December 2020, Pages 48-53

ELSEVIER

Original Research

Multiple deprivation and geographic distance to community physical activity events — achieving equitable access to parkrun in England

P.P. Schneider^a, R.A. Smith^a, A.M. Bullas^a, H. Quirk^a, T. Bayley^a, S.J. Haake^a, A. Brennan^a, E. Goyder^a

Wellcome Open Research

Wellcome Open Research 2020, 5:9 Last updated: 29 JUN 2020

Check for updates

RESEARCH ARTICLE

Does ethnic density influence community participation in mass participation physical activity events? The case of parkrun in England [version 2; peer review: 2 approved, 1 approved with reservations]

Robert Smith¹, Paul Schneider¹, Alice Bullas², Steve Haake², Helen Quirk², Rami Cosulich¹, Elizabeth Goyder¹

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

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



Example: HTA



heRvis
Introduction
Input data
Outputs

Welcome to the **health economic Rshiny visualisation builder (heRvis)**.

Health Economists regularly use MS Excel to undertake economic evaluations. However, Excel plots often look very basic and dated. This tool allows you to take the outputs from Excel model, and create publication quality plots and tables within minutes.

No programming knowledge is required. All the user needs to do is copy and paste their results into the tool, which will then create plots and tables using packages from R software environment in the background (e.g. DT, ggplot2, and many others). You can download the plots for use in your presentations and reports.

The tool is currently set up to create the following visuals:

- ICER-Table
- Cost-Effectiveness Plane
- Cost-Effectiveness Acceptability Curve(s)

Tutorial - see below

Quick tutorial: how to use heRvis?

Step 0

If you just want to check out how the tool works, go to:

heRvis was created by Robert Smith & Paul Schneider of Dark Peak Analytics.
If you have any comments or suggestions feel free to contact us at:
darkpeakanalytics@gmail.com

Go Back
Next Step

heRvis
Introduction
Input data
Outputs

How many strategies?

3

Threshold

30000

☐ Remove 1st row labels

Reset all fields

Load example

Review Data

Stability Plot

Strategy 1
Pick a color
Base Case
#D93025

Strategy 2
Pick a color
Dupmap
#336699

Strategy 3
Pick a color
Supmap
#FF9933

Copy-paste

QALYs	costs
5.666103	16640.79
6073568	5.630113
1	5
5.447610	22026.14
8702233	9107568
2	21475.68
5.400929	5833607
5.400929	5833607

Copy-paste

QALYs	costs
5.482932	19240.28
9571181	5.684227
5	5
5.915258	22342.85
4079608	0802833
4	5
5.488766	27039.91
8357761	5.666666

Copy-paste

QALYs	costs
5.673151	19141.76
4864684	4524.474
7	27712.57
5.313702	9482537
6228035	0
4	256971.52
5.502230	01889.32
4306431	5.666666

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darkpeakanalytics@gmail.com

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Next Step

heRvis
Introduction
Input data
Outputs

Choice

ICER-Table Cost-Plane ICER-Table

Select Reference

Base Case

Cost-effectiveness Plane

Results of Probabilistic Sensitivity Analysis:

Base Case vs. Dupmap Supmap

Download Plot

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

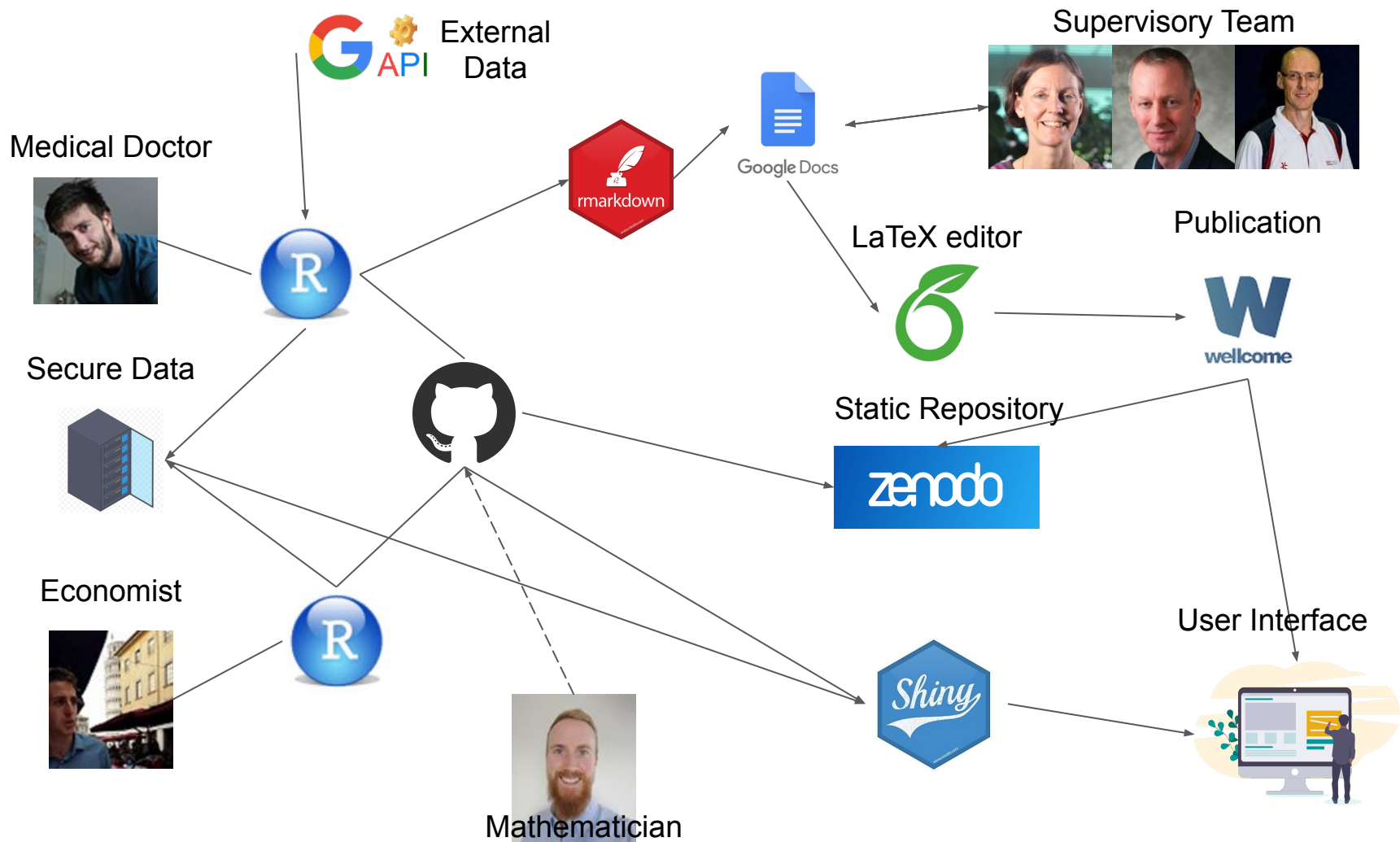


Thanks from Sheffield



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





Background





Background





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)	
		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		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)

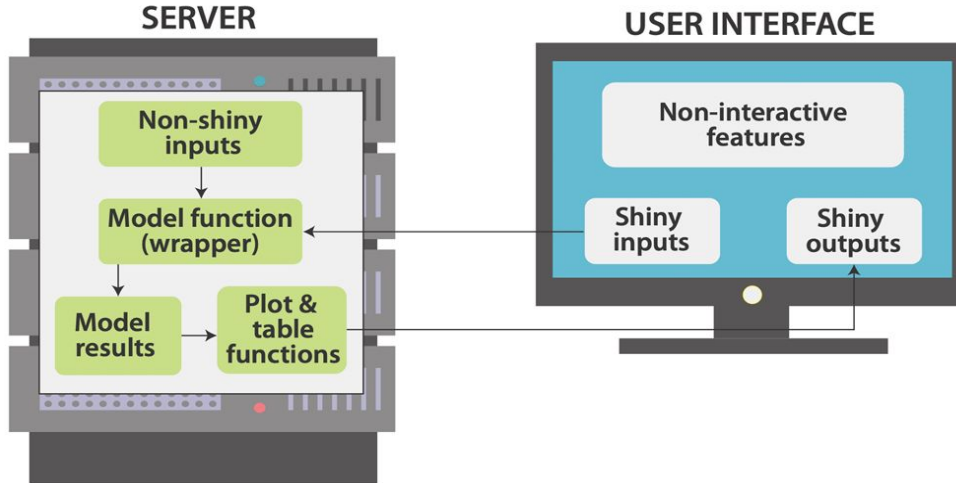
Brennan, A., Chick, S.E. and Davies, R., 2006. A taxonomy of model structures for economic evaluation of health technologies. *Health economics*, 15(12), pp.1295-1310.



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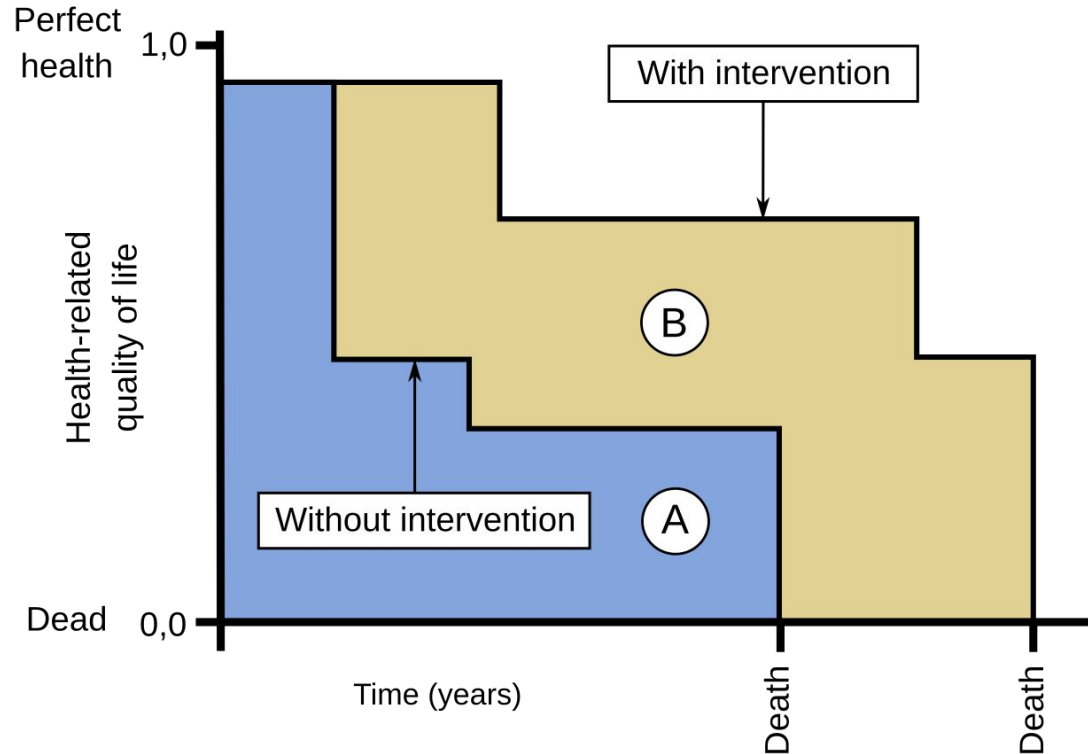
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Background





Modelling framework

