Using R for Health Economics Modelling in Consulting: R (are) We There Yet?

JE Poirrier,

Executive Director, HEOR Modelling

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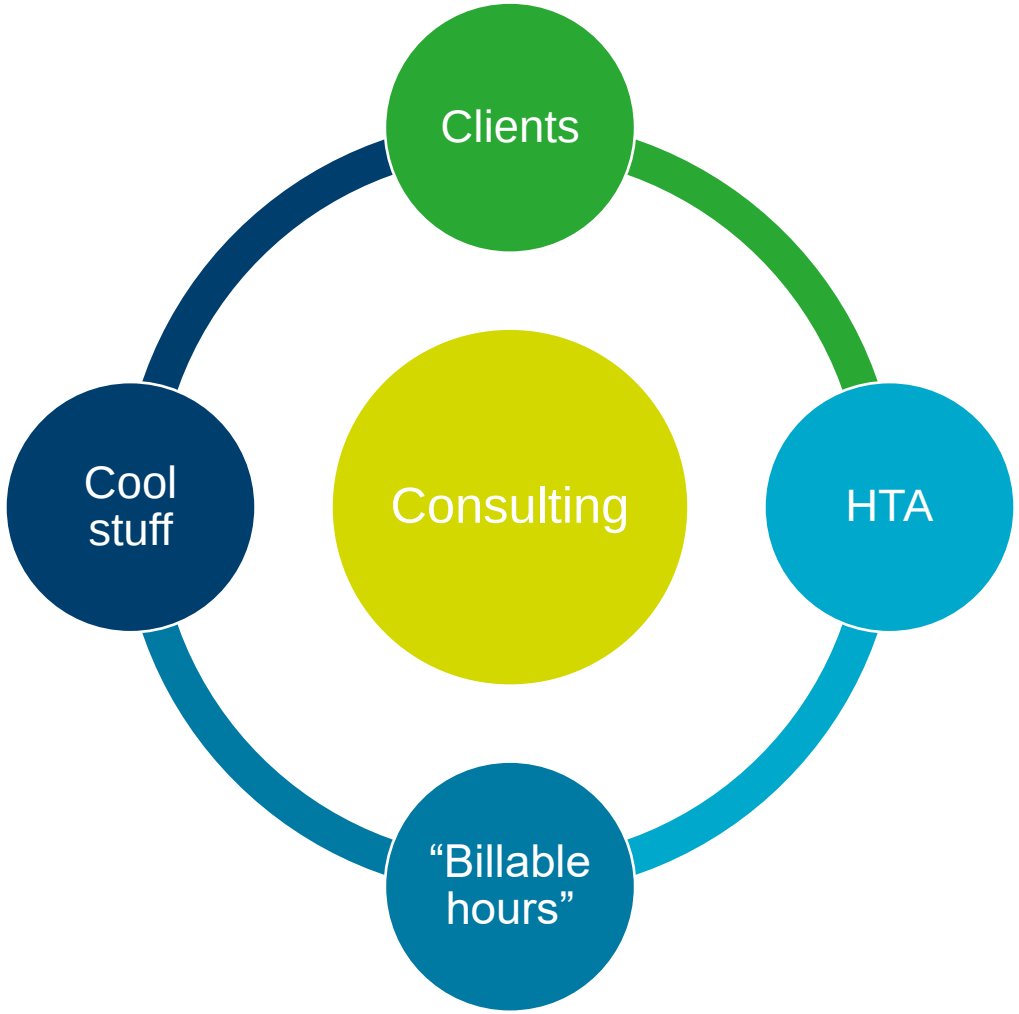
Disclaimer

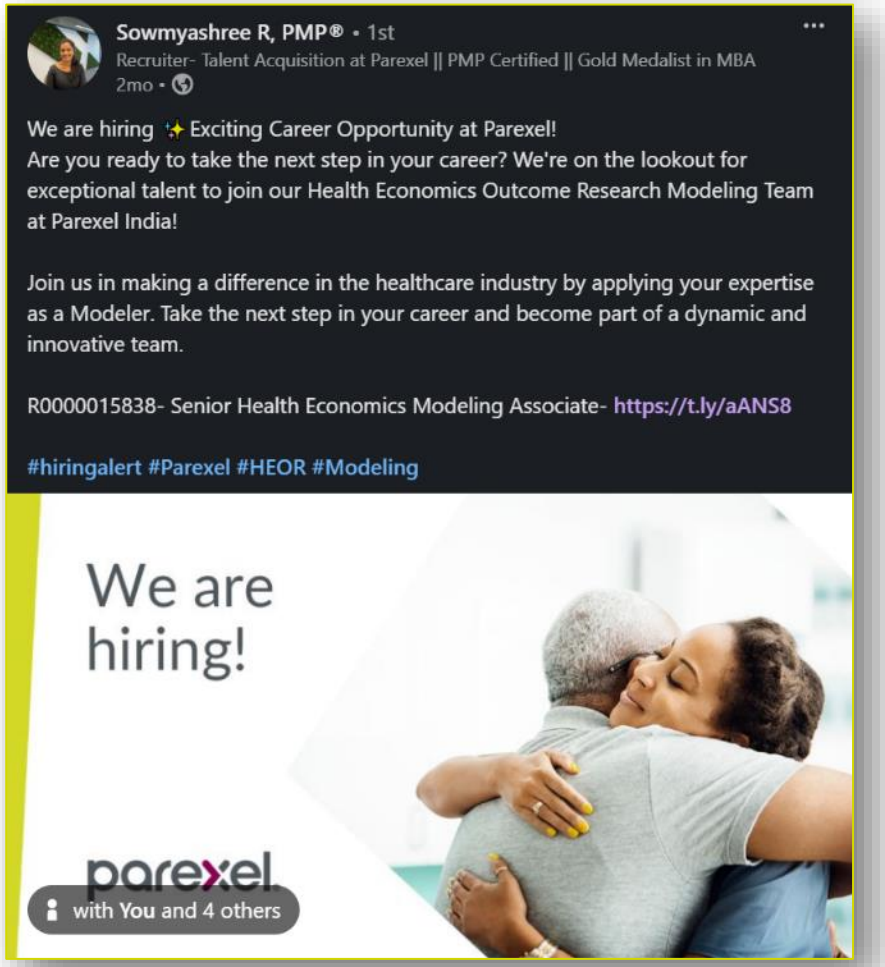
This deck represents my experience over the years in Consulting. It is not an endorsement from my employer and is not necessarily the opinion of my employer.

Consulting is at an exciting intersection in HEOR Modelling



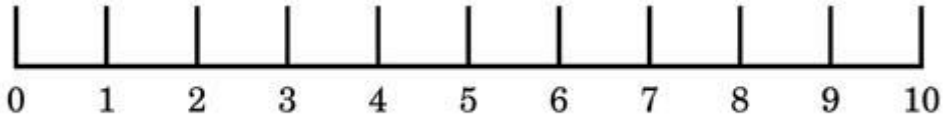
HEOR: Health Economics and Outcomes Research; HTA: Health Technology Agency

1. The interviews



A simple visual analog scale for knowledge of R

- On a scale from 0 to 10, how do you rate your skills in R?
  - If you don’t know what R is, just answer 0
  - If you are an R guru and you can teach all of us, use 10



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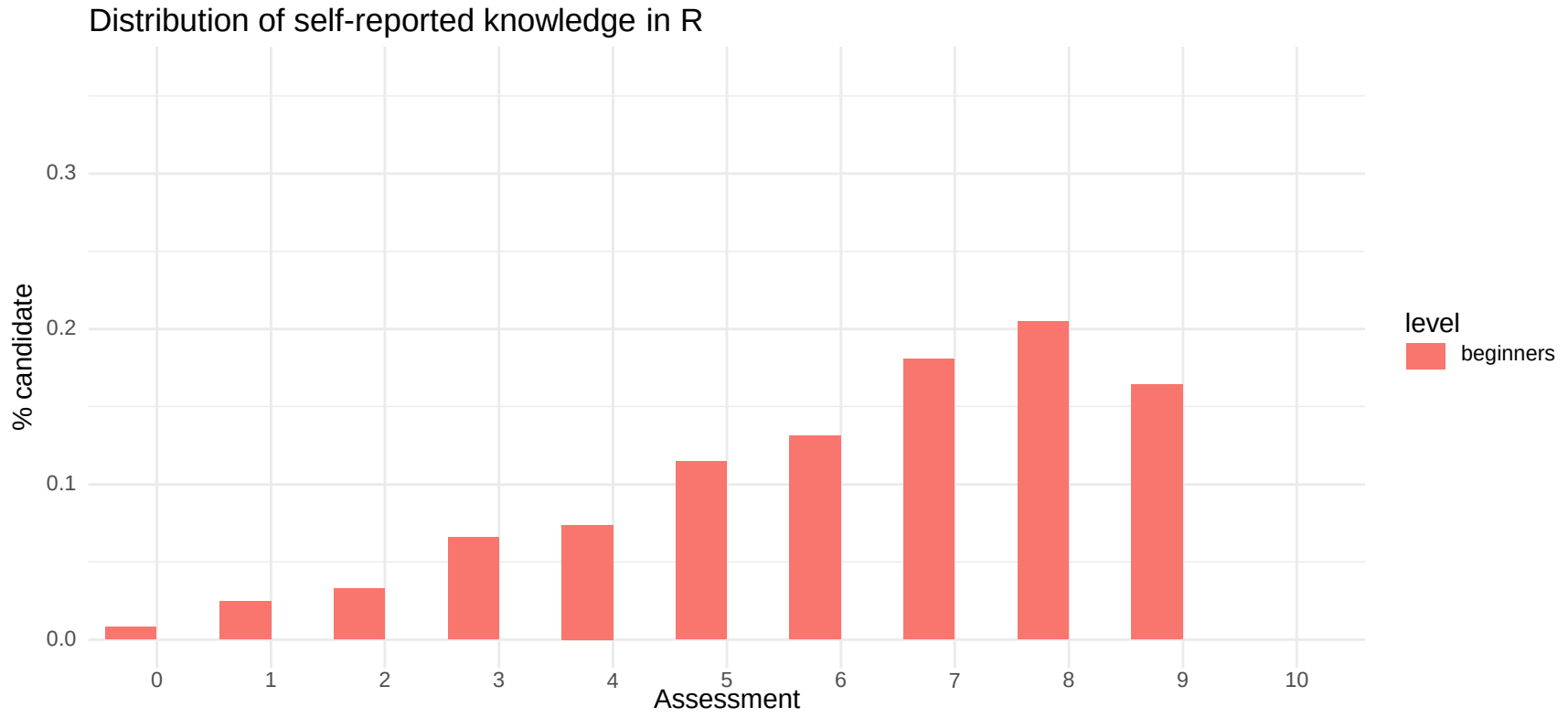

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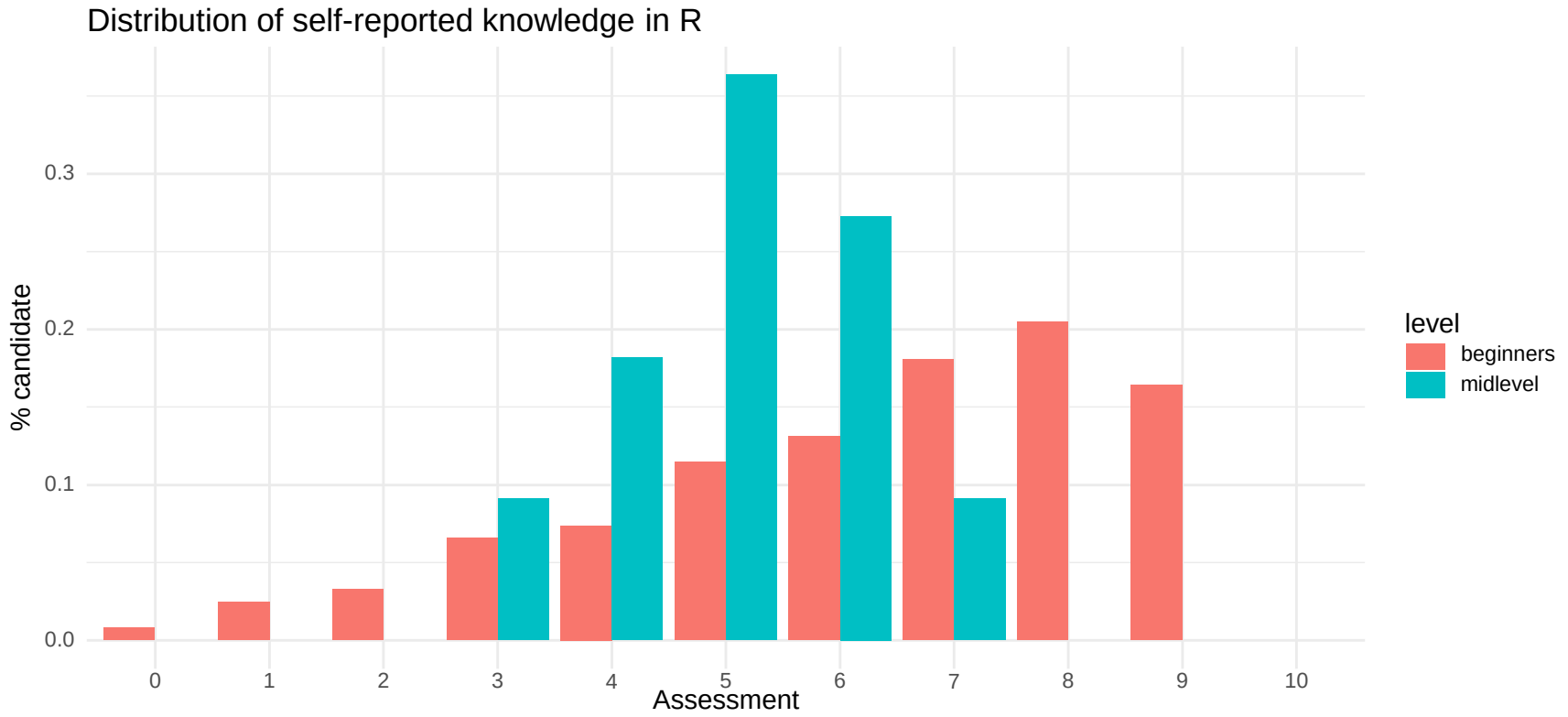
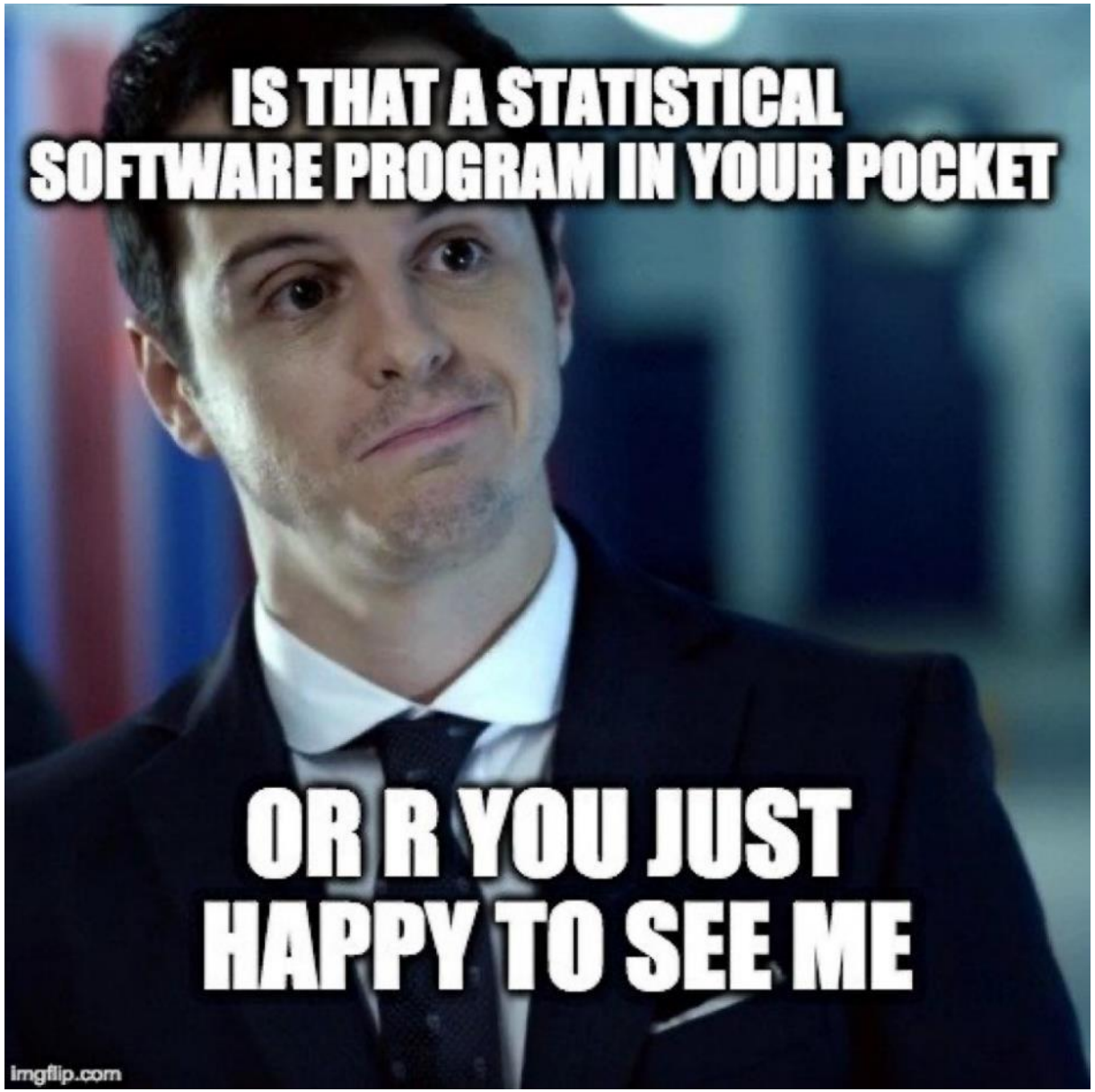


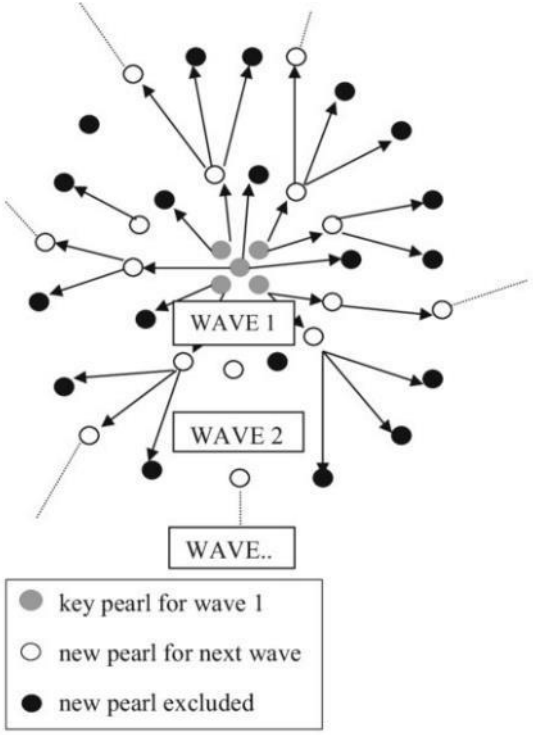


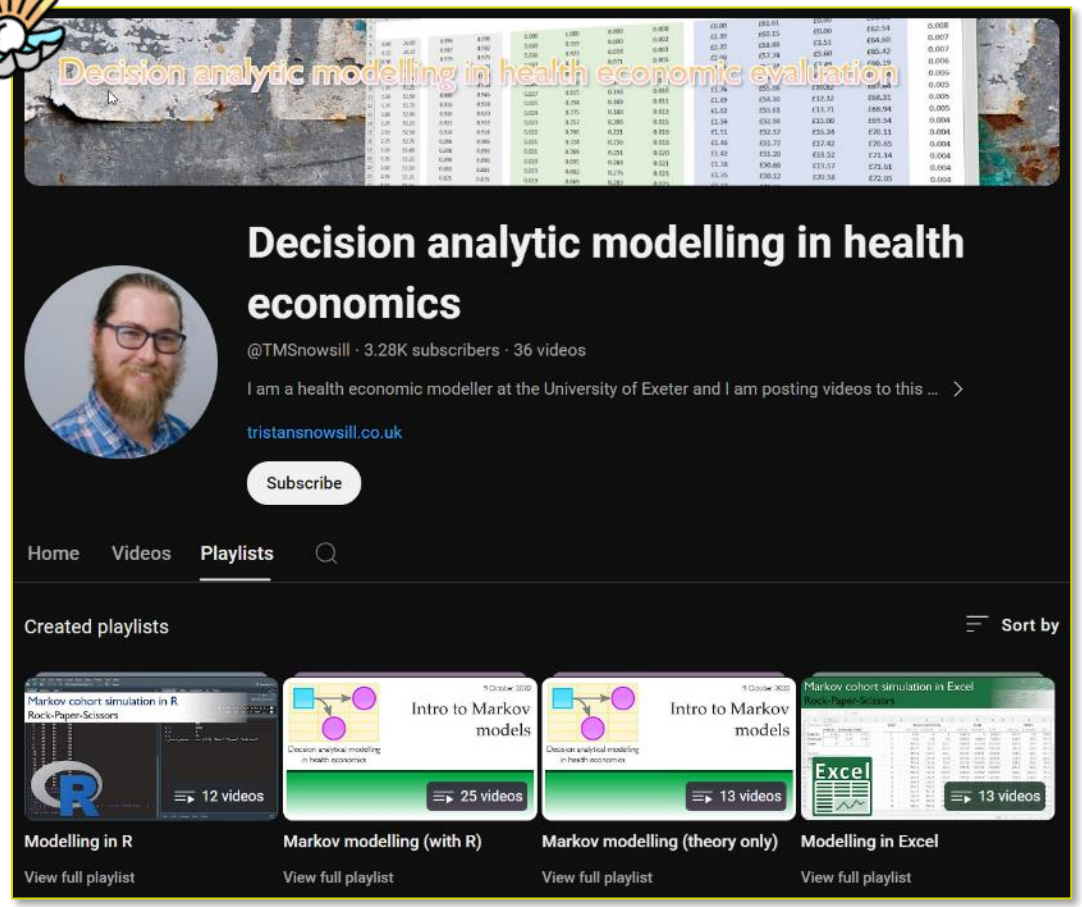
2. Following new R modellers

They need to know / learn a lot!

Since Friday:
AssertHE to be added …

Learn R (update your knowledge) in HEOR





(left) Mitchell et al., 2017: 10.1007/s11205-016-1356-8 ; (right) https://www.youtube.com/@TMSnowsill/playlists

R accompanies model development from start to finish

Disease area analysis

Model type

TPP analysis

Data gap analysis

Data extraction

Model skeleton

Model programming

QC, face validity, reproducibility

Model finalisation

Technical Report

Technical Deck

Adaptation (HTA requests)

Response to HTA / payers

Adaptation (country-specific)

Adaptation (new trial data)

Other adaptations

Cost-Effectiveness Model development activities timeline

Clinical Trial Consulting firm: standards
Internal R programming guidelines
Internal R env. & packages

3. Starting with the end: healthcare intervention reimbursement

HTA agencies start to accept R in their reimbursement submissions, and some updated their guidelines

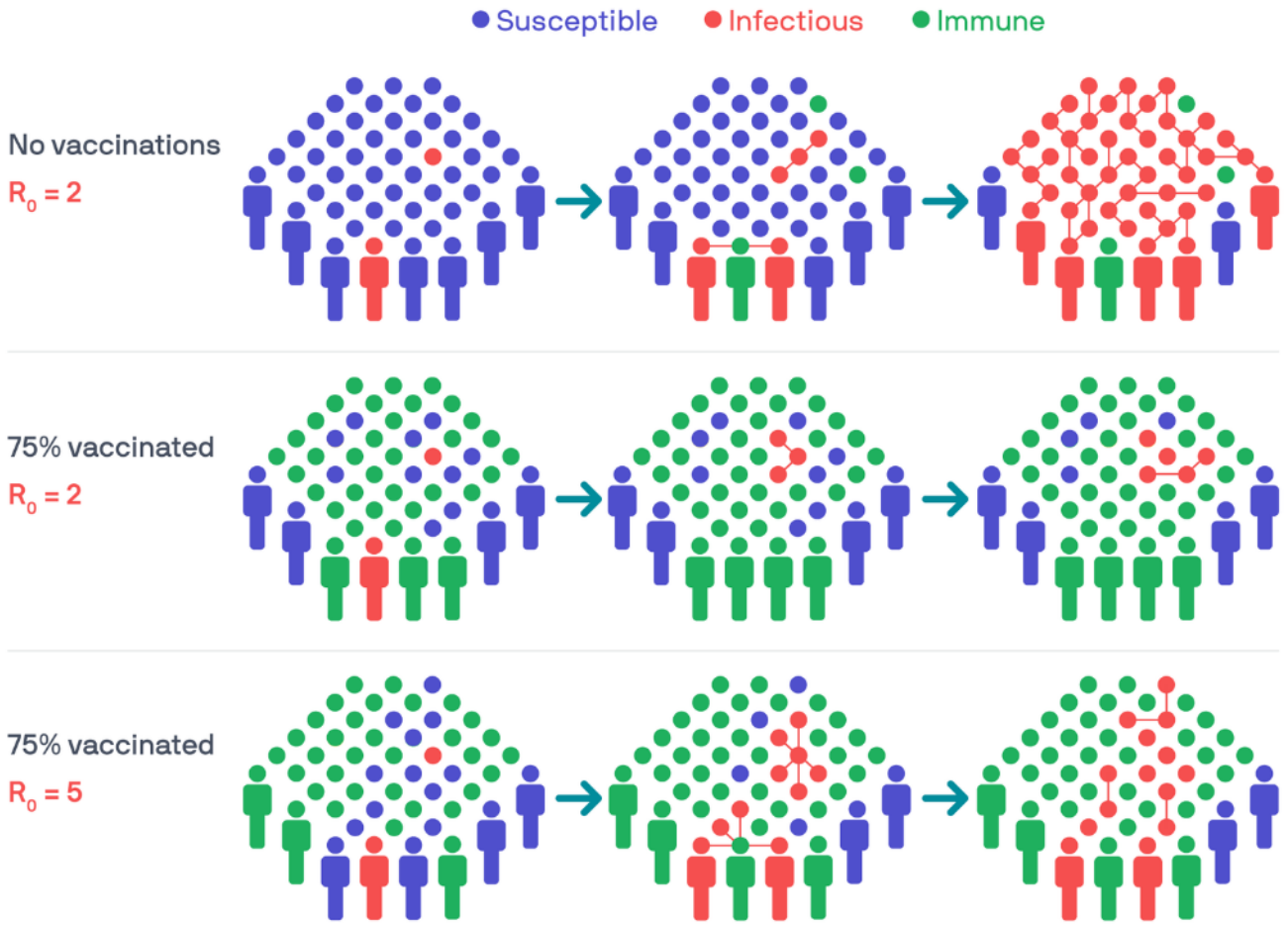
- NICE: "*NICE accepts fully executable economic models using standard software, that is, Excel, DATA/Treeage, R or WinBUGs*"
- IQWiG: "*a technical documentation in which the functional/mathematical relations of the model components are presented, so that an expert third party can replicate the results of the model independently of a specific software*"
- ZIN guidelines (cf. previous talk)

- But most HTA agencies are perceived as they will only accept MS Excel
- There is therefore a reluctance from large pharmaceutical companies to start a "global" model in R because some of the local adaptations (forks) will need to be in Excel

NICE PMG36; IQWiG General Methods, 2022

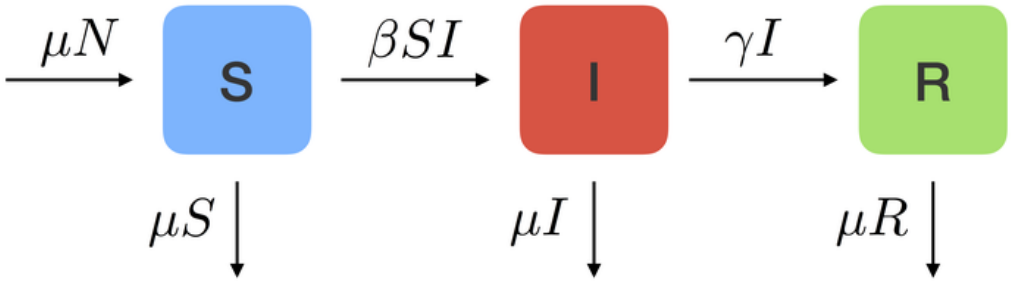
4. Reimbursing vaccines

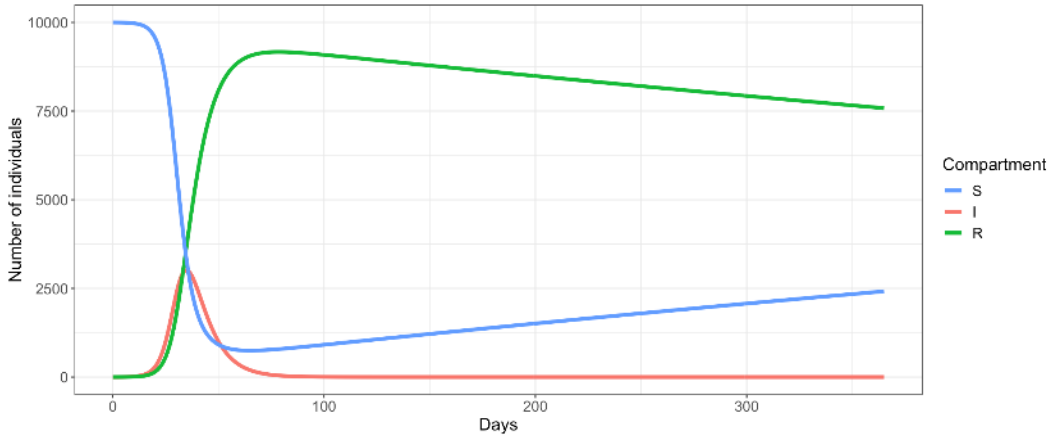
Herd immunity



Credit: Kiwan, A. Understanding the journey to herd immunity. PATH 2021

S-I-R dynamic transmission models

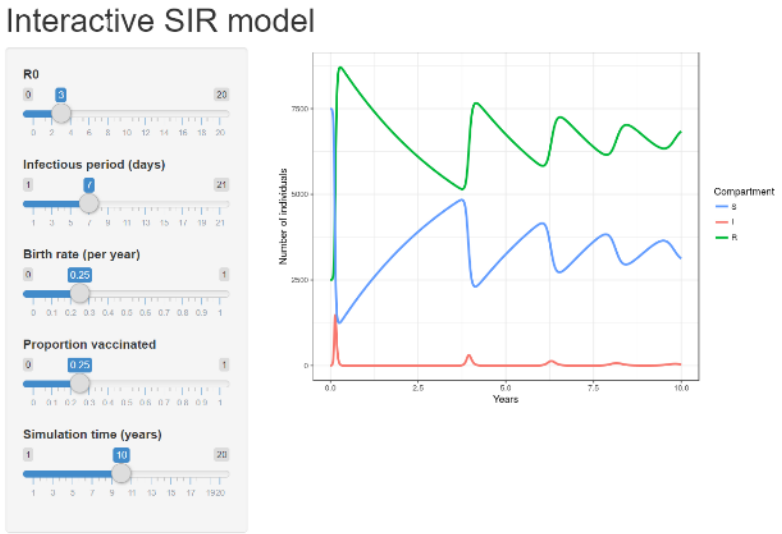




- S: susceptibles individuals
- I: infected individuals
- R: Removed (recovered) individuals

- μN: the number of births into the population per day
- βSI: the number of susceptible individuals that become infected per day
- μS (or μI/ μR): the number of susceptible (or infected/ immune) individuals that die per day
- γI: the number of infected individuals that recover per day.

Introducing vaccination:



Sinead Morris: shinyR on GitHub

{deSolve} at the center of vaccine models

Encapsulate your model in a function:

```
Lorenz <- function(t, state, parameters) {
        with(as.list(c(state, parameters)),{
                # rate of change
                dX <- a*X + Y*Z
                dY <- b * (Y-Z)
                dZ <- -X*Y + c*Y - Z

                # return the rate of change
                list(c(dX, dY, dZ))
        }) # end with(as.list...
}
```

Solve the model by using the ode integration function:

```
> require(deSolve)
> out <- as.data.frame(ode(y=state,
times=times, func=Lorenz,
parms=parameters))
> head(out)
```

Soetaert et al. Package deSolve: Solving Initial Value Differential Equations in R, The R Journal 2(2):5-15, 2010

HTA agency acceptance of dynamic transmission models varies

- In 2012,
  - NICE (PHE) introduced maternal immunisation against pertussis based on a dynamic model (Matlab)
  - PBAC re-introduced an 18-month vaccine dose against DTP based on a dynamic model (Matlab)
- Many HPV vaccines are reimbursed with dynamic transmission cost-effectiveness models, some written in R *
- Recent RSV vaccines were recommended by ACIP in the US (Excel)
- Note the Report of the ISPOR-SMDM Modeling Good Research Practices Task Force on Dynamic Transmission Modeling (2012) mentions R but also gives some caveats:

> There are several software packages either designed or easily adapted for dynamic transmission models. This includes Stella by isee Systems and Berkeley Madonna. Many of these packages contain graphical user interfaces to allow rapid development and enhance communication, and most have multiple calculation options for numerical procedures. However, the modeling environments may prevent users from implementing some desired modeling assumptions. Thus, many analysts prefer to produce their own custom code in Matlab, R, C/C++, or other programming environments. This allows the greatest flexibility in terms of modeling assumptions, model calibration, uncertainty analysis, and choice of numerical techniques. However, this approach requires the most development effort, and the programs may lack transparency to those not familiar with these environments.

* Hagens et al. 10.3390/vaccines12040438, 2024 for instance ; ISPOR: Pittman et al. 10.1016/j.jval.2012.06.011, 2012

Using R for Health Economics Modelling in Consulting: R (are) We There Yet?

- Progress has been made
- The R ecosystem is more and more user-friendly
  - A growing number of new health economists know R (at least a little bit)
  - A growing number of HTA agencies allow R explicitly
- A more structured learning approach is needed to speed up further adoption

Thank you!

jep.poirrier@parexel.com

With Heart™