# Microsimulation Sick-Sicker model with time dependency with PSA

Includes individual characteristics: age, age dependent mortality probabilities, individual treatment effect modifyer, time dependency for the sick (S1) state, increasing change of death in the first 6 year of sickness (tunnel)

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- Jalal H, Pechlivanoglou P, Krijkamp E, Alarid-Escudero F, Enns E, Hunink MG. An Overview of R in Health Decision Sciences. Med Decis Making. 2017; 37(3): 735-746. https://journals.sagepub.com/doi/abs/10.1177/0272989X16686559
- Krijkamp EM, Alarid-Escudero F, Enns EA, Jalal HJ, Hunink MGM, Pechlivanoglou P. Microsimulation modeling for health decision sciences using R: A tutorial. Med Decis Making. 2018;38(3):400–22. https://journals.sagepub.com/doi/abs/10.1177/0272989X18754513
- Krijkamp EM, Alarid-Escudero F, Enns E, Pechlivanoglou P, Hunink MM, Jalal H. A Multidimensional Array Representation of State-Transition Model Dynamics. Med Decis Making. 2020 Online first. https://doi.org/10.1177/0272989X19893973

```r
rm(list = ls())      # clear memory (removes all the variables from the workspace)
```

## 01 Load packages

```r
if (!require('pacman')) install.packages('pacman'); library(pacman) # use this package to conveniently
 # load (install if required) packages from CRAN
 p_load("here", "dplyr", "devtools", "scales", "ellipse", "ggplot2", "lazyeval", "igraph", "ggraph", "r
 # load (install if required) packages from GitHub
 # install_github("DARTH-git/dampack", force = TRUE) Uncomment if there is a newer version
 p_load_gh("DARTH-git/dampack")
```

## 02 Load functions

```r
source("Functions.R")
```

## 03 Input model parameters

```r
set.seed(1)  # set the seed

# Model structure
n_t   <- 30                         # time horizon, 30 cycles
n_i   <- 100000                     # number of simulated individuals
v_n   <- c("H", "S1", "S2", "D")  # the model states names
n_s   <- length(v_n)                # the number of health states
d_r   <- 0.03                       # discount rate of 3% per cycle
v_dwe <- v_dwc <- 1 / ((1 + d_r) ^ (0:n_t))    # discount weight
v_names_str <- c("no treatment", "treatment")  # strategy names
n_str <- length(v_names_str)      # number of strategies

### Event probabilities (per cycle)
# Annual transition probabilities
p_HS1   <- 0.15                     # probability of becoming sick when healthy
p_S1H   <- 0.5                      # probability of recovering to healthy when sick
p_S1S2  <- 0.105                    # probability of becoming sicker when sick

# Annual probabilities of death
# load age dependent probability
p_mort   <- read.csv("mortProb_age.csv")
# load age distribution
dist_Age <- read.csv("MyPopulation-AgeDistribution.csv")

# probability to die in S1 by cycle
p_S1D    <- c(0.0149, 0.018, 0.021, 0.026, 0.031, rep(0.037, n_t - 5))
p_S2D    <- 0.048             # probability to die in S2

# Cost inputs
c_H     <- 2000               # cost of one cycle in the healthy state
c_S1    <- 4000               # cost of one cycle in the sick state
c_S2    <- 15000              # cost of one cycle in the sicker state
c_D     <- 0                  # cost of one cycle in the dead state
```

```r
c_Trt   <- 12000            # cost of treatment (per cycle)

# Utility inputs
u_H     <- 1                # utility when healthy
u_S1    <- 0.75             # utility when sick
u_S2    <- 0.5              # utility when sicker
u_D     <- 0                # utility when dead
u_Trt   <- 0.95             # utility when sick(er) and being treated
```

# 04 Sample individual level characteristics

## 04.1 Static characteristics

```r
# your turn
v_x     <- runif(n_i, min = 0.95, max = 1.05) # treatment effect modifier at baseline
```

## 04.2 Dynamic characteristics

```r
# your turn
```

## 04.3 Create a dataframe with the individual characteristics

```r
df_X    <- #data.frame( # ADD ALL CHARACTERISTICS )
```

# 05 Define Simulation Functions

There is no need to make two functions for each strategy. We recomment to make one `Probs()`, one `Cost()` and one `Effs()` function and have an function argument `Trt = FALSE` which you "switch" on and off of the strategy of interest.

Please see the example below:

```r
cost_stay <- function (days = 0, Trt = FALSE) {
  # days: days an individual is staying in a care facility
  # Trt:  is the individual treated? (default is FALSE)

  c_stay_day <- 100   # the price to stay a day at the care facility
  c_Trt <- 3000       # the price of treatment, total price for drug. Drug requires one dose

  cost <- c_stay_day * days + Trt * c_Trt

  return(cost)       # return the pric e
}

cost_stay_noTrt <- cost_stay(days = 10, Trt = FALSE) # run the function for the no treatment strategy
cost_stay_Trt   <- cost_stay(days = 10, Trt = TRUE) # run the function for the treatment strategy

cost_stay_noTrt
cost_stay_Trt
```

### 05.1 Probability function

The function that updates the transition probabilities of every cycle is shown below. Please make sure you correctly incorporate the time dependency

```
# your turn

# In this function you have to incorporate age specific mortaility and incorporate the change in probab
```

### 05.2 Cost function

The `Costs` function estimates the costs at every cycle.

```
# your turn

# Make sure you incorporate the cost of the treatment in the treatment strategy
```

### 05.3 Health outcome function

The `Effs` function to update the utilities at every cycle.

```
# your turn

# Make sure you incorporate the treatment effect modifier
```

## 06 Run Microsimulation

You have to run the function twice. Once for the treatment strategy and once of the no-treatment strategy

```
# your turn
```

## 07 Visualize results

```
# your turn
```

## 08 Cost Effectiveness Analysis

```
# your turn
```