

# Modeling DALYs in Amua

[Back to Website](#)

# Learning Objectives

- Review of DALY health outcomes
- Tips and tricks for modeling DALYs in Amua

# Overview of DALY Outcomes

[Back to Website](#)

# Common Outcomes

## 1. Occupancy-based payoffs:

- Utility/DALY weight applied for a time period / step.
- Treatment/disease cost per time period / step.

## 2. Transition-based payoffs:

- One-time event-based cost (e.g., disease-related death, initial Dx, etc.).
- One-time health outcome (e.g., years of life lost to premature mortality)

# Disability-Adjusted Life Years (DALYs)

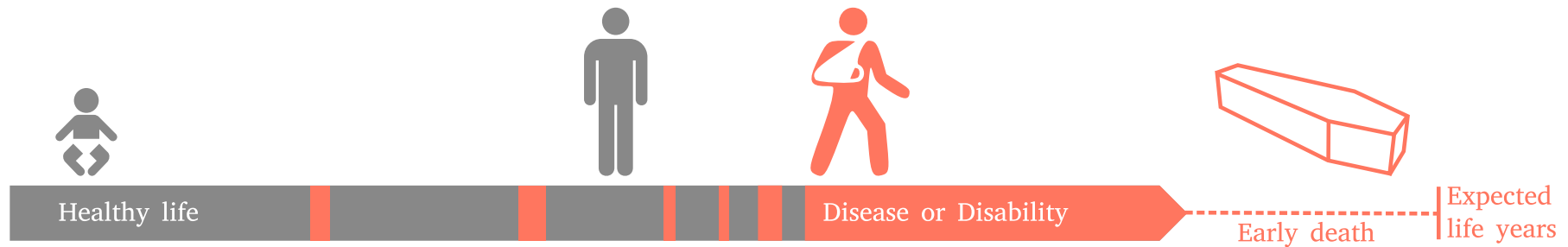
- Reflect both occupancy- and transition-based payoffs.
- There's also *very* little guidance on how to structure a decision model for DALY outcomes.
- We'll show you how today!

- Origin story: Global Burden of Disease Study
- Deliberately a measure of health, not welfare/utility
- Similar to QALYs, two dimensions of interest:
  - Length of life (differences in life expectancy)
  - Quality of life (measured by disability weight)

Disability Adjusted Life Year is a measure of overall disease burden, expressed as the cumulative number of years lost due to ill-health, disability or early death

$$= \text{YLD} + \text{YLL}$$

Years Lived with Disability + Years of Life Lost



# DALYs = YLL + YLD

- YLL (Years of Life Lost)
- YLD (Years Lived with Disability)

# Years of Life Lost to Disease

For a given condition  $c$ ,

$$YLD(c) = D_c \cdot L_c$$

- $D_c$  is the condition's disability weight
- $L_c$  is the time lived with the disease.



# Years of Life Lost to Premature Mortality

- YLL are defined by by a “loss function.”
- Drawn from a reference life table, indicating remaining life expectancy at age  $a$ .

- $$YLL(a) = Ex(a)$$

# Years of Life Lost to Premature Mortality

[Back to Website](#)

$$DALY(c, a) = YLD(c) + YLL(a)$$

# Evolution of DALY Calculations

- **Historical Practice:** Initial GBD studies applied age-weighting and 3% annual time discounting.
- **Changes Post-2010:** Discontinuation of these practices for a more descriptive DALY measure.

# Current Discounting Practices

- **WHO-CHOICE:** Time discounting of health outcomes.
- **Our Methodology:** Continuous-time discounting from original GBD equations is retained.

# Takeaways

- Modeling DALYs in Amua is straightforward if you don't use discounting.
  - For YLDs, use disability weight like you would a utility weight.
  - For YLLs, use one-time “cost” of remaining life expectancy.
    - $YLL =$   
`tbl_reference_life_table[initial_age + t, 1]`

# Takeaways

- But if you do need to discount ...
  - You're going to see some math expressions that take care of discounting for YLL outcomes.
  - This math adds some complexity but not much insight, so I'll gloss over it a bit
  - We'll provide you the formulas to use here and in the .amua model file.

# Mathematical Formulation for DALYs in AMUA

- $YLD(c) = D_c$ .
- $YLL(a, t) = Ex(a) \exp(-\ln(1 + r) * t)$ .
  - $a$  is the time of death
  - $r$  is the discount rate you're using in the model (e.g., 3%).
  - $t$  is the cycle number at which premature death occurs.



# Mathematical Formulation for DALYs in AMUA

- $YLD(c) = dw\_c.$
- $YLL(a, t) = tbl\_ref\_lt[initial\_age+t, 1] * \exp(-\log(1 + r\_disc) * t).$

# Overview of Decision Problem

- Progressive disease model (from case study)
- Focus only on cohort of individuals who develop mild disease.
- Follow until death (from disease-related or other causes)

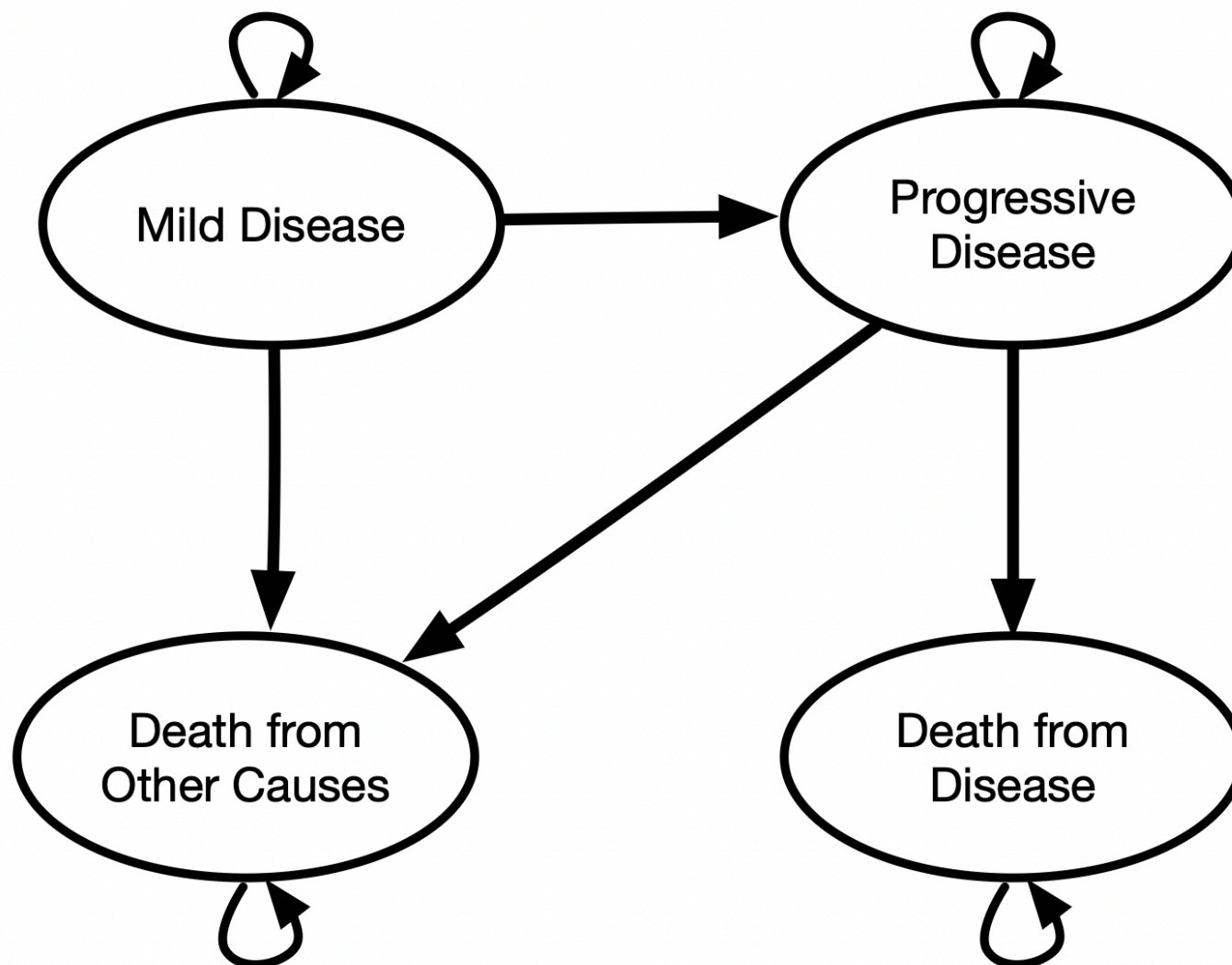
# Overview of Decision Problem

- Major difference from case study: can ignore Healthy state.
- Strategies: Status quo, prevention, treatment

# Methods: Structuring the Model

[Back to Website](#)

# State Transition Diagram



[Back to Website](#)

# Defining Outcomes in Amua

- YLD: New Outcome. Use disability weights instead of utility weights!
- YLL: One-time “event” at time of death from disease.
  - “Cost”: present value of remaining life expectancy at age  $t$  in the model.
  - Intuition: we penalize premature death from disease using the remaining life expectancy at the age in which the person dies.
- Need to also define the discount rate as a parameter  $r_{disc}$



# Interactive Amua Session

[Back to Website](#)

# Occupancy-Based Payoff: YLD

- YLD is an “occupancy-based” payoff (i.e., YLD increments by disability weight for each cycle in that health state).
  - Add `dw_mild = 0.08`
  - Add `dw_progressive = 0.15`
  - Add `dw_progressive_treated = 0.13`
- Mild disease state: `dw_mild`
- Progressive disease state: `dw_progressive`



# Transition-Based Payoff: YLL

- Remaining life expectancies are drawn from the reference life table, or from an endogenous life table.
- Import reference life table as lookup table—just like we did with background mortality, etc.
- Remember to use the “Truncate” option because the life table may not extend to the maximum age in the model.

# Life Expectancy & YLL

- **Contextual Choices:** Remaining life expectancy values may vary by research context ([Anand and Reddy 2019](#)).
- **Historical Method:** GBD uses an *exogenous* life table approximating maximum human lifespan.
- **Alternatives:** *Endogenous* tables or models may be preferred in certain cases.

# Exogenous vs. Endogenous Life Tables

- **Distinction:** Source of life expectancy values (external vs. internal).
- **Exogenous:** Independent mortality risks, using GBD's reference table.
- **Endogenous:** Specific to the population's mortality risks and health states.

# Incremental CEA

- ICERs are based on cost per DALYs *averted*
- Must export expected cost and DALY outcomes, then do ICER calculations outside Amua (e.g., Excel)
- Alternative: define YLL and YLD outcomes as their negative values.
  - CEA will work, but expected values will be negative.

# Thanks!

Draft manuscript (with R code) available online at <https://graveja0.github.io/dalys/>



[Back to Website](#)

# References

Anand, Sudhir, and Sanjay G. Reddy. 2019. "The Construction of the DALY: Implications and Anomalies." *SSRN Electronic Journal*.  
<https://doi.org/10.2139/ssrn.3451311>.