

## Code Challenges

### 1. Simple decision tree

Taken from Hazen (2014). Competing cancer and AIDS risks decision tree. Assume discrete time of single years. An individual starts in the Well state. They can transition into Dead, Cancer & AIDS, Cancer, AIDS or remain in the Well state.

Event probabilities are

- $\delta_0 = 1.182 \times 10^{-3}$ : Die from other causes
- $\delta_c = 0.025$ : Die from recurrent prostate cancer
- $\delta_a = 0.080$ : Die from AIDS
- $\beta_c = 0.0027$ : Cancer recurs
- $\beta_a = 0.0083$ : Develop AIDS

### 2. Markov-cycle tree

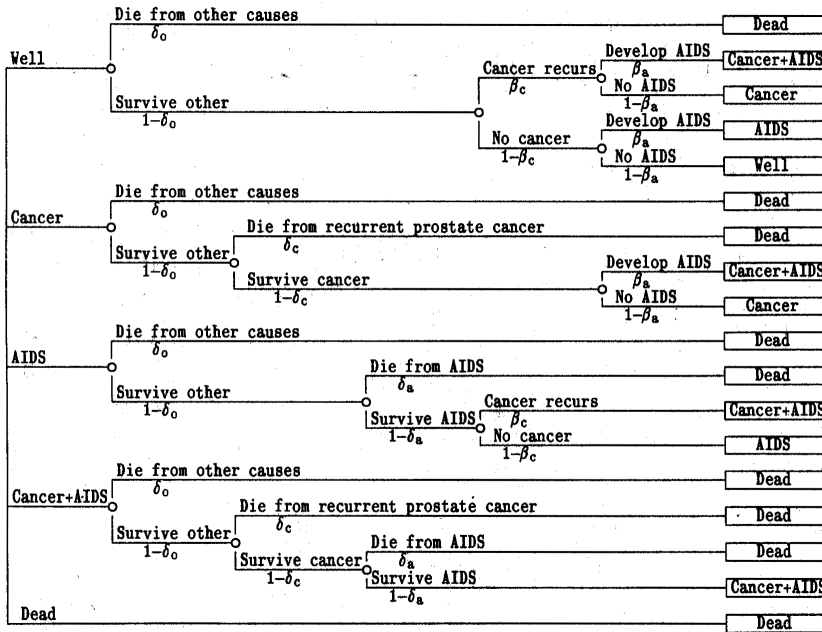
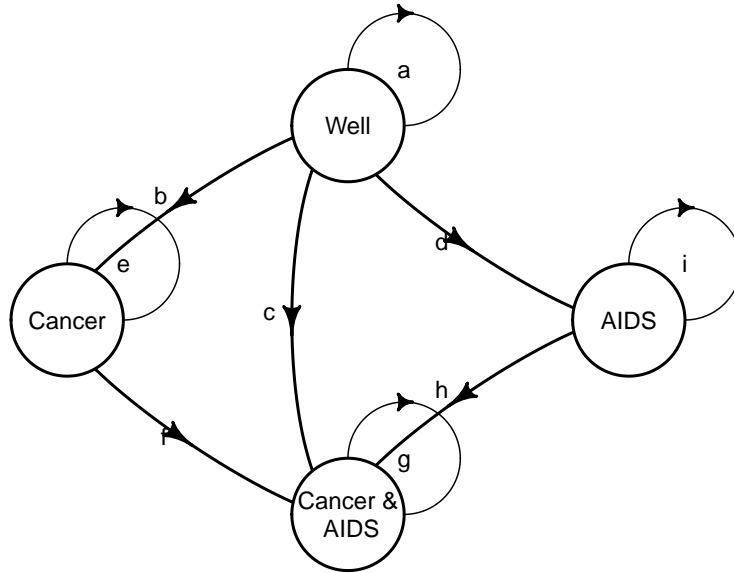


FIGURE 1. Markov-cycle tree for competing cancer and AIDS risks.

### 3. Discrete-time Markov model



### Calculate mean QALYs

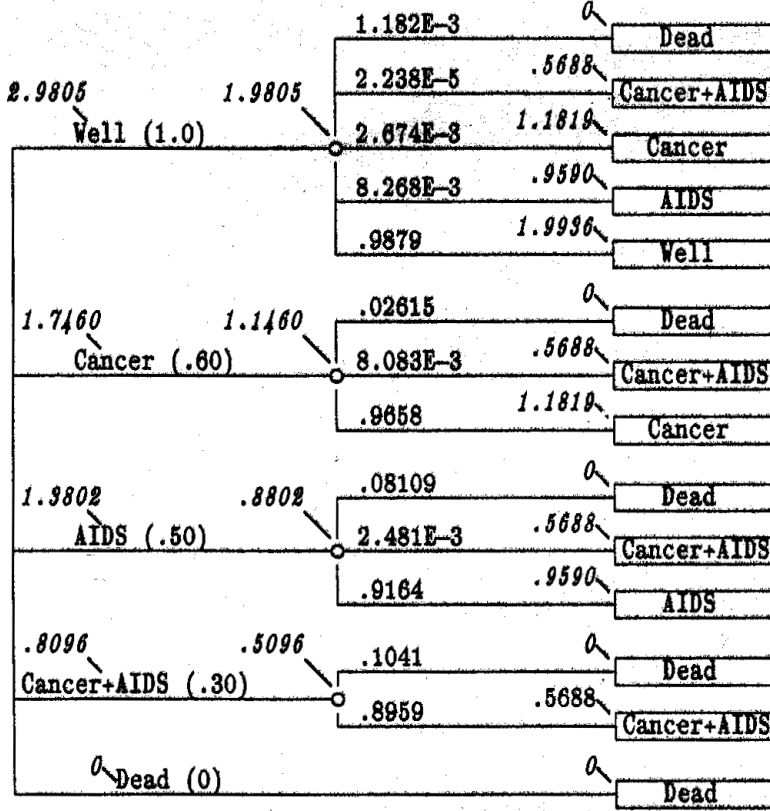
Calculate cumulative proportion of patient cycles in each state and take product with health utilities for each respectively.

Define the state utilities  $R(\cdot)$ :

- Well: 1.0
- Cancer: 0.60
- AIDS: 0.50
- Cancer & AIDS: 0.30
- Dead: 0

### 4. One-cycle Markov-cycle tree

We can rearrange the Markov-cycle tree to closer resemble to Markov model by collapsing the branches into a single cycle and simply combining the probabilities.



## 6. Roll back Markov-cycle tree

We can calculate the mean QALYs using the markov-cycle tree representation without calculating the cumulative proportion of time of patient cycles in each health state. This is done by rolling back using the recursive equation (value iteration):

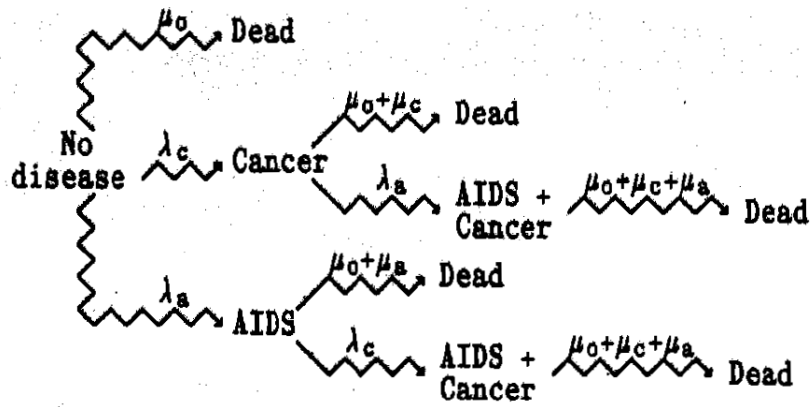
$$V_n(i) = R(i) + \sum_j p_{ij} V_{n-1}(j)$$

## 5. Roll back stochastic tree

So far we have only considered discrete time. The Markov-cycle tree representation can be extended to continuous time as a *stochastic tree*. Probabilities are now replaced by rates. This change is represented by zigzag lines in the diagrams. This is clearly a more compact representation.

We can calculate mean QALY in an analogous way to the discrete-time case by rolling back using the recursive equation:

$$V(S) = \frac{R(i)}{\sum_j \lambda_j} + \sum_j p_j V(S_j)$$



- Cancer:  $\lambda_c = 0.03250/\text{year}$
- AIDS:  $\lambda_a = 0.10/\text{year}$
- Dead from Cancer:  $\mu_c = 0.3081/\text{year}$
- Dead from AIDS:  $\mu_a = 0.9970/\text{year}$
- Dead other:  $\mu_0 = 0.014191/\text{year}$

Hazen, Gordon B. 2014. "Stochastic Trees : A New Technique for Temporal Medical Decision Modeling," no. August 1992. <https://doi.org/10.1177/0272989X9201200302>.