Cohort state-transition model variations in R

Using R for Decision Modeling in Health Technology Assessment

CE16

NIHES Erasmus Medical Center Rotterdam

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Time-dependency

- **Since start of the model**
- Transition probabilities often depend on age
  - Background mortality
  - Risk of developing disease or experiencing an event

- **Depending on state residency**
- Some transition probabilities depend on time since an event, not age
  - e.g., The risk of developing recurrence among newly diagnosed cancer patients declines with time

- In other words, matrix P is not the same every cycle

TIME DEPENDENCY SINCE START OF THE MODEL

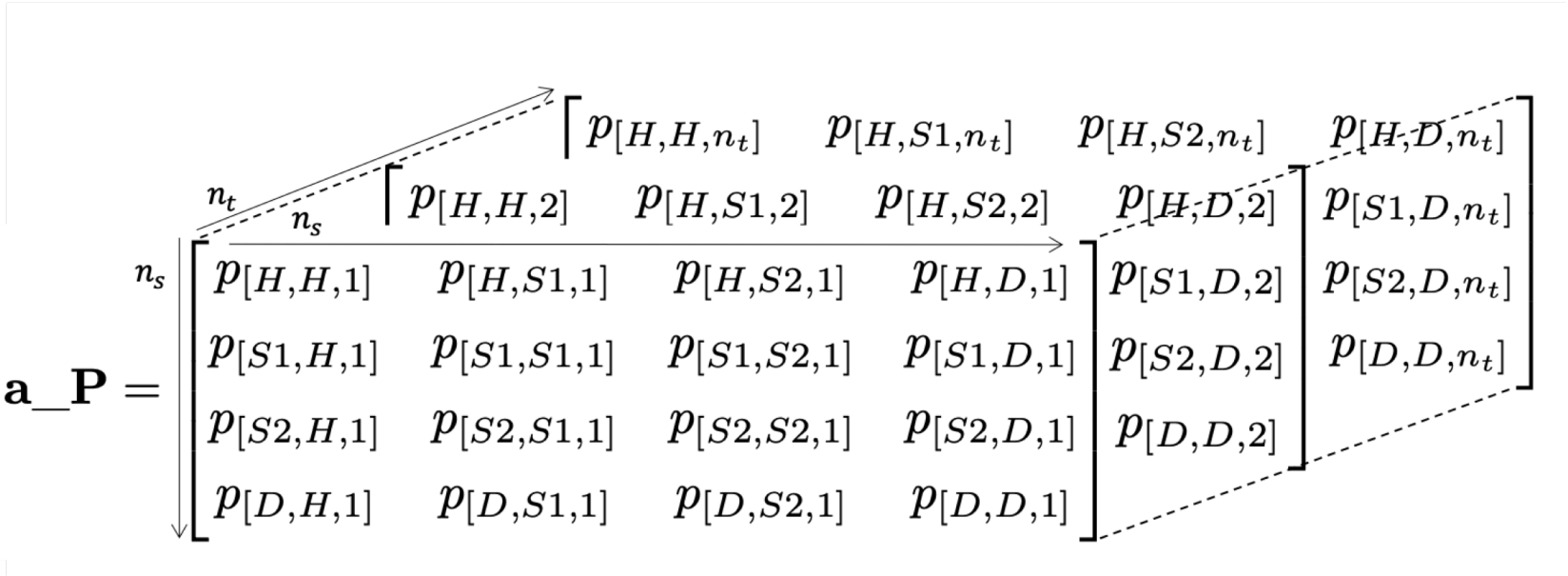
Time-dependency since model start

- Transition probabilities often depend on time since model start
  - Background mortality
  - Risk of developing disease or experiencing an event
- In other words, matrix P is not the same every cycle
- Replace matrix P with matrices P_t, where t is time since model start

Time-varying probabilities in R

- We create a 3D array, `a_P`, that stores a collection of time-varying transition matrices, P_t, in the third dimension

- For the Sick-Sicker Markov model:



R Session –
3 state example

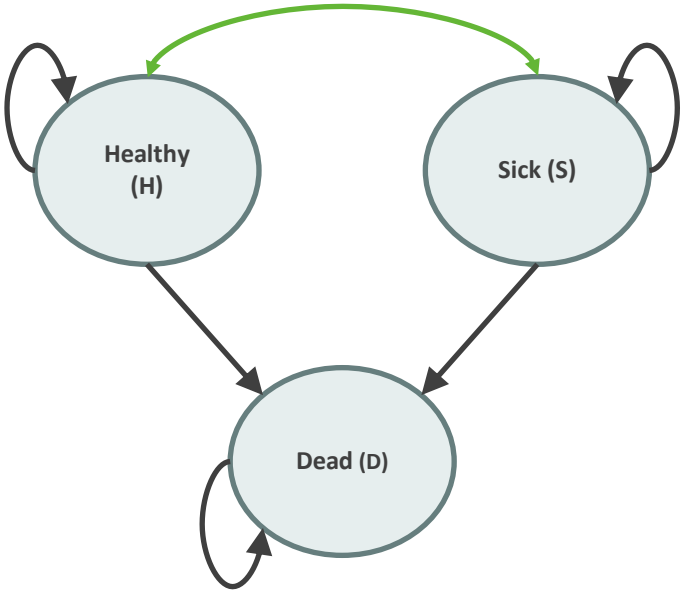
TIME-DEPENDENT BASED ON STATE RESIDENCE

Other Types of Dependence

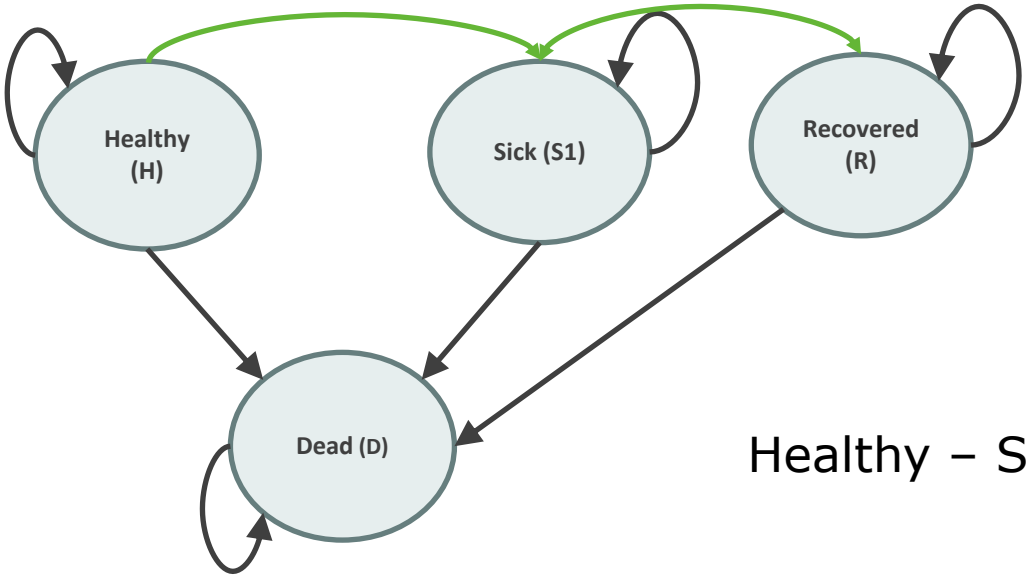
- "Memoryless" property of Markov models is a BIG assumption
  - Transition probabilities only depend on the current state and not on past states
- Many transition probabilities depend on model history, not time since model start
  - Risk of myocardial infarction (MI) greater for persons with prior MI
  - Effectiveness of a drug used as first-line therapy may be better than if used as second-line therapy

When history matters, create more states…

Healthy – Sick - Dead:



Once recovered, the risk of getting sick again or dying increases



Healthy – Sick – Recovered - Dead

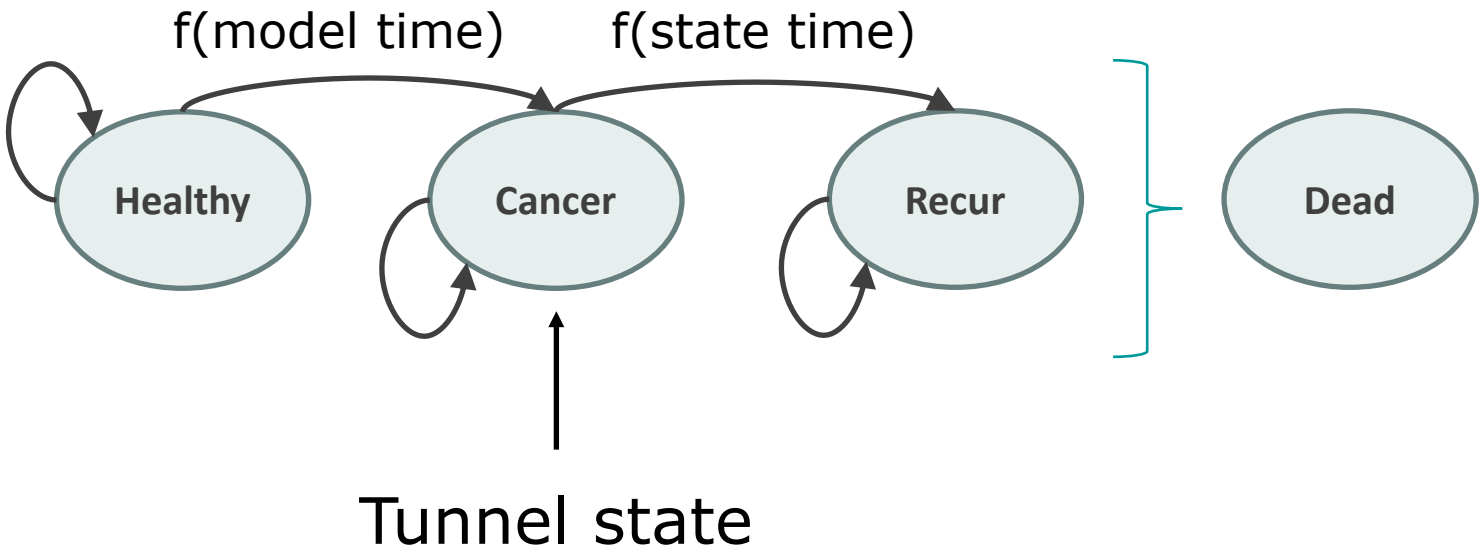
Tunnel states

If transition probabilities do not depend on the time since model start, replacing P with P_t does not work

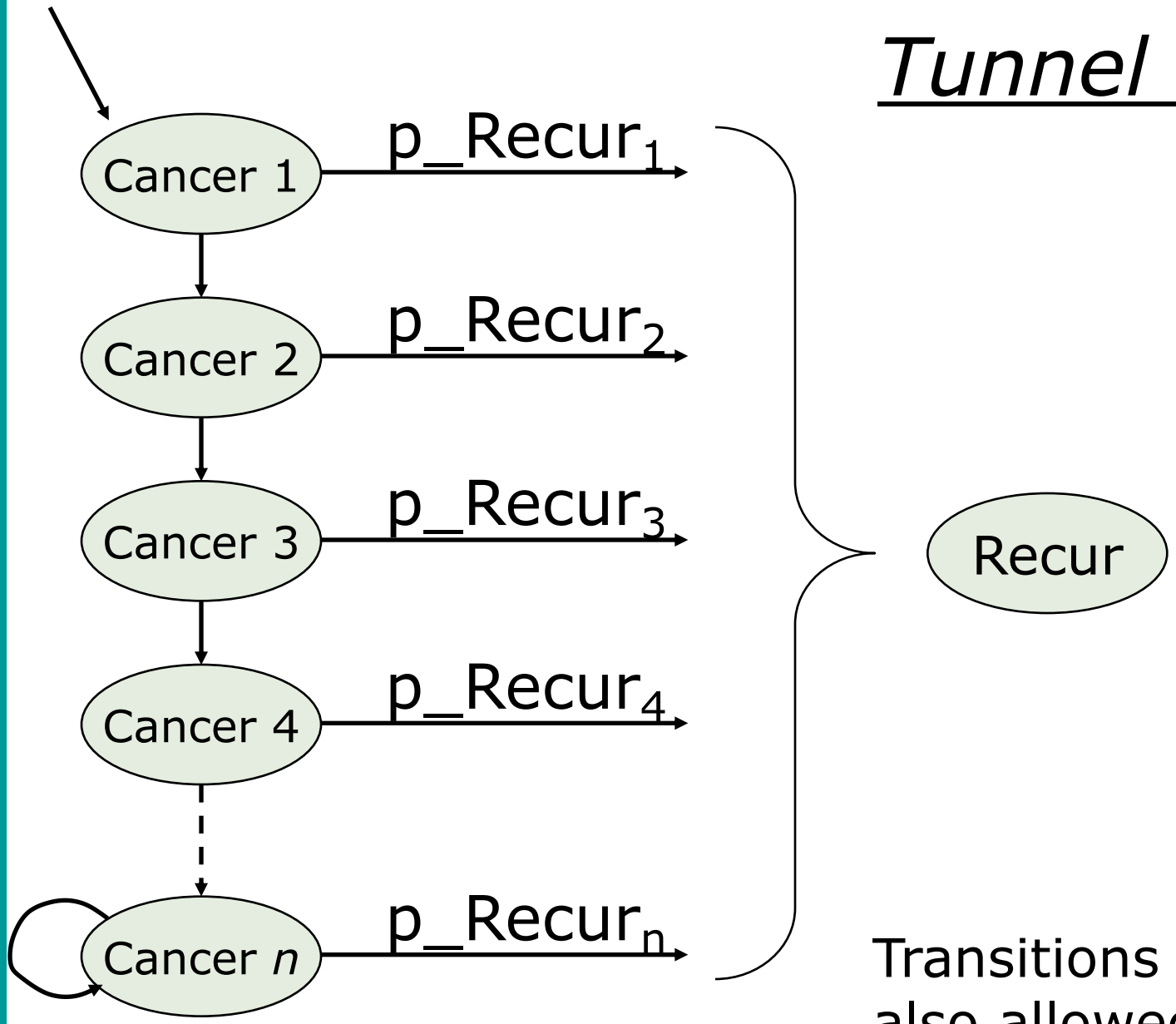
- E.g., Cohort of healthy patients at risk for cancer, but once cancer is diagnosed the risk of recurrence depends on time since diagnosis

- Solution?
  - Create "tunnel" states

State Time


f(model time)
f(state time)
Healthy
Cancer
Recur
Dead
Tunnel state

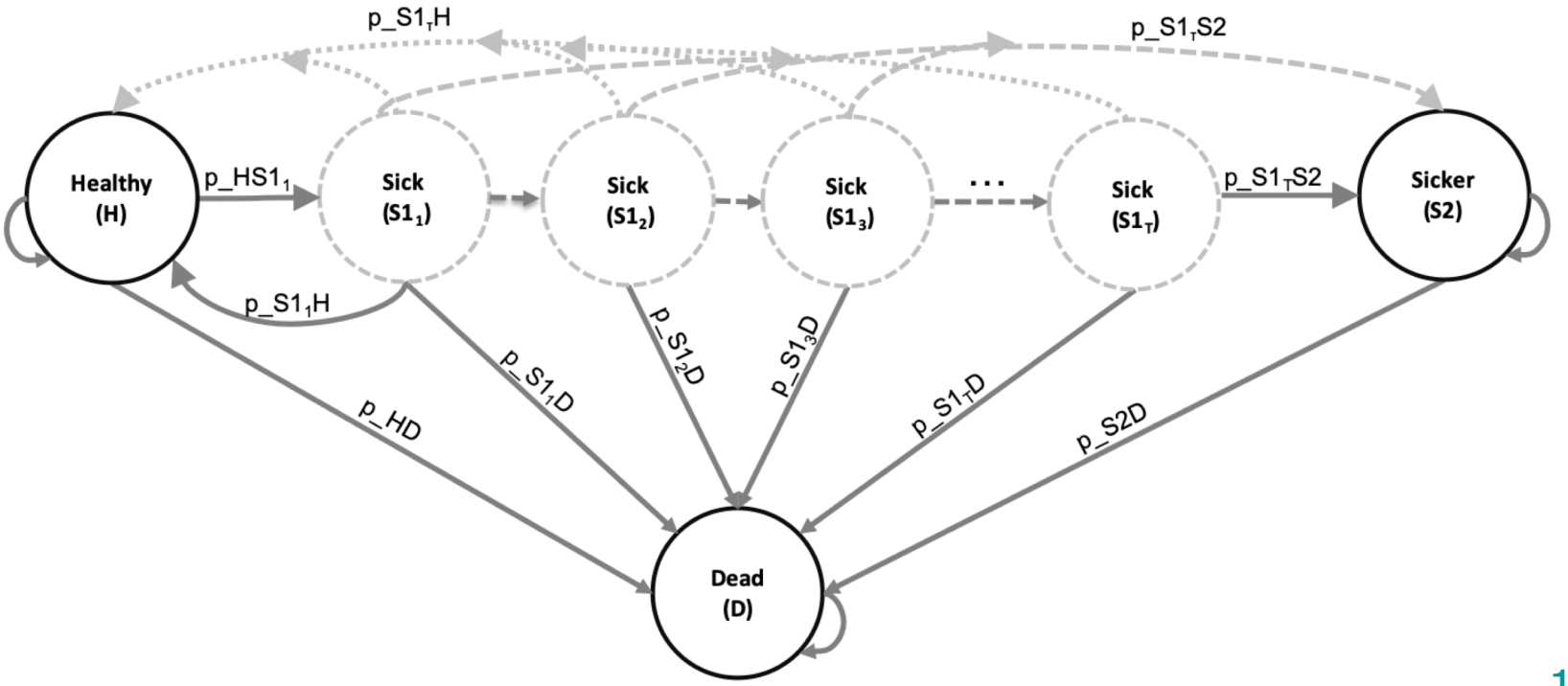
Tunnel States



Transitions to Dead also allowed.

Time-dependent probabilities

- Expand the states of the 3D array by the number of cycles considered in the time-dependency variable(s)
- For the Sick-Sicker Markov model:



R Session

R Excercise

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