Sunday 27th of October 8:30 to 12:00

Time	Description	Discussant
[15 min]	(0) Introductions and administrivia	Trikalinos
[25 min]	(1) DES as a composition of point processes	Alarid-Escudero
[30 min]	(2) NHPPPs – key properties	Trikalinos
[30 min]	(3) Sampling from NHPPPs	Sereda
[15 min]	**Break**	
[80 min]	(4) Guided exercise: - Implement a simple cancer natural history DES for one person - The many-person case - Packaging	[All] Chrysanthopoulou Sereda/Alarid-Escudero Trikalinos
[10 min]	(5) Advanced Topic Teaser on self-excitatory processes: point processes that are not NHPPPs and when you may need them	Trikalinos
[15 min]	General Q & A	All

Section 1: Big picture

Background

Individual-level **discrete-time simulation** models usually require sampling of which event happens each cycle.

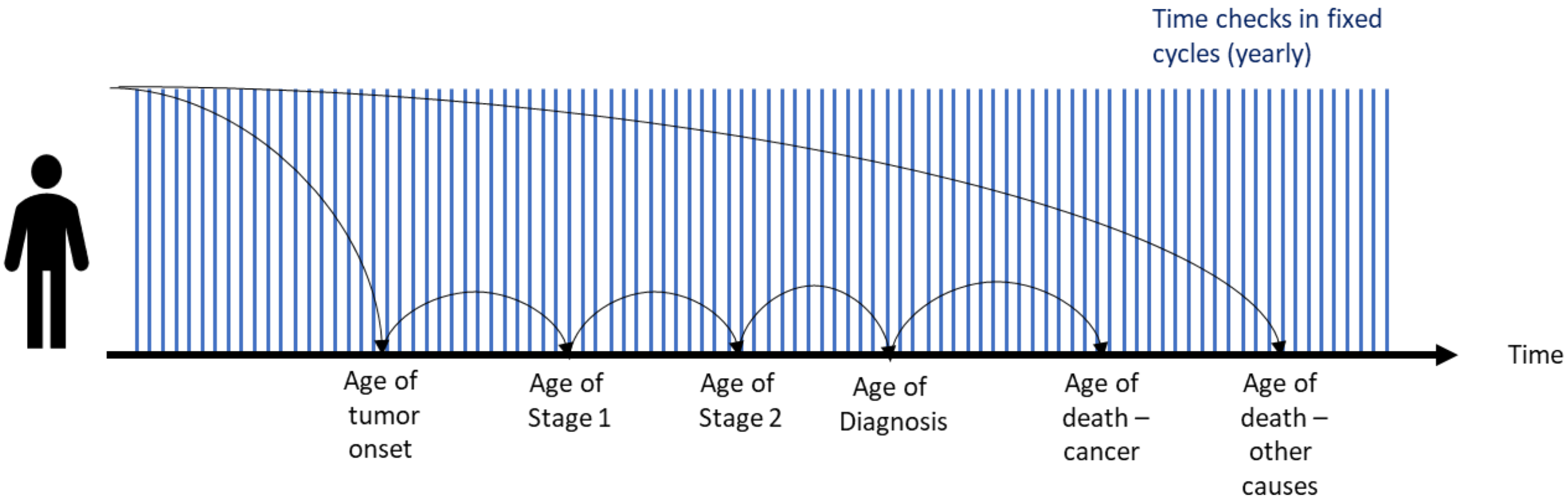

Figure courtesy of Carlos Pineda

Background

Individual-level **discrete-event simulation** (**DES**) models usually require sampling times at which specific transitions or events could occur.

Animation courtesy of Carlos Pineda

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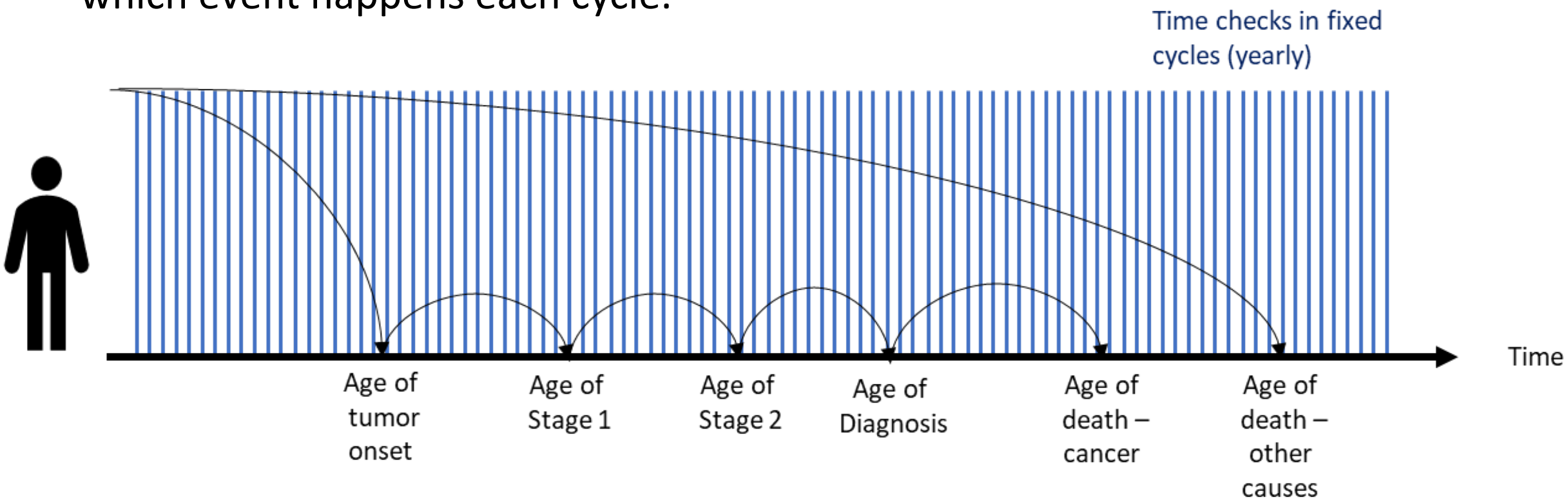


Figure courtesy of Carlos Pineda

Background

Individual-level **discrete-event simulation** (**DES**) models usually require sampling times at which specific transitions or events could occur.

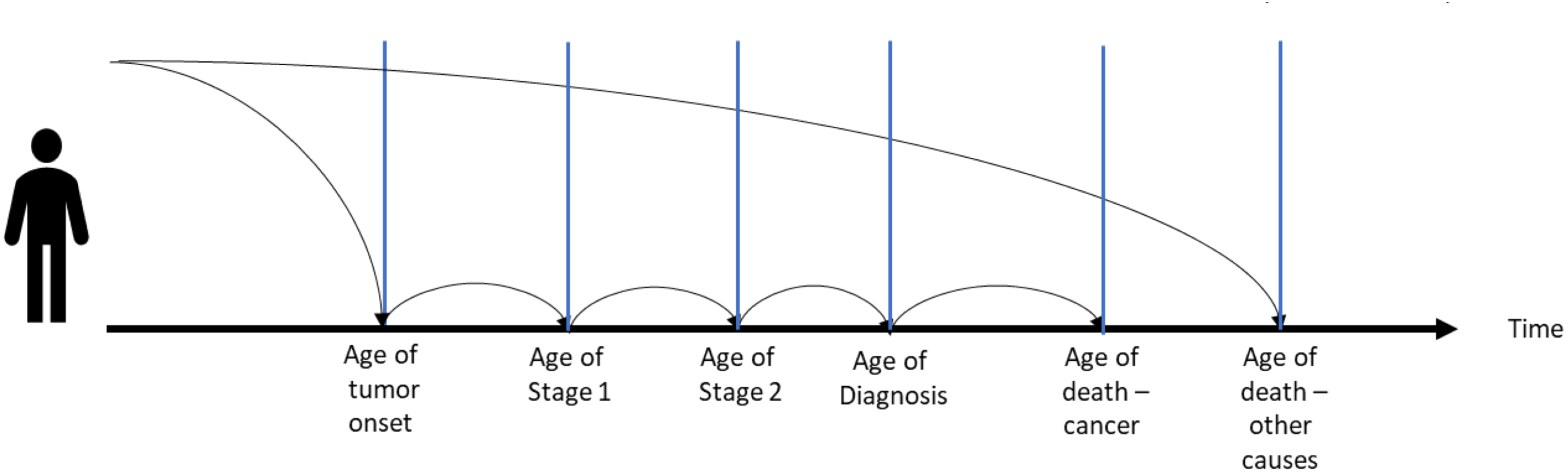


Figure courtesy of Carlos Pineda

Background

One **individual** at a time

-> **inefficient** in high-level languages like R or Python

Background

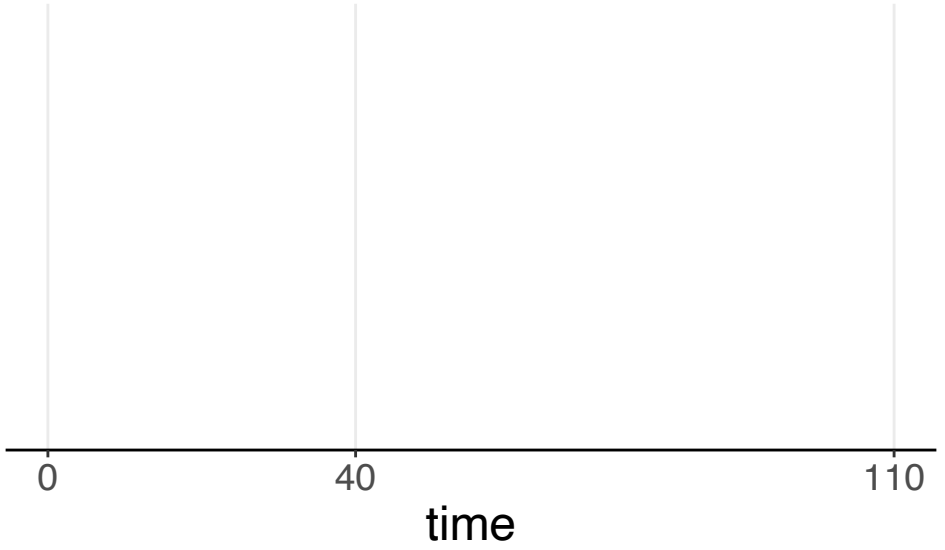
One **event** at a time

-> **efficient** in high-level languages like R or Python

Graphical notation

The time horizon of the simulation

- Stop the simulation at 110



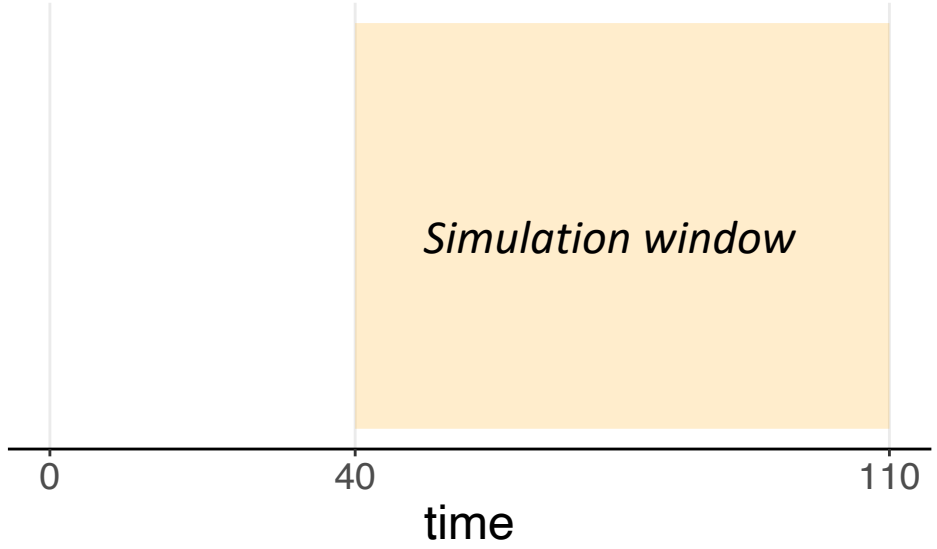
All times in years

Graphical notation

We are interested in the interval from 40 to 110

- Spawn cancer-free at 40
- Stop the simulation at 110

All our cancer-related events may occur in the shaded window.



Graphical notation: Type of events

1. **Exactly one event**

2. **At most one event**

3. **Zero, one, or more events**

Simulation window

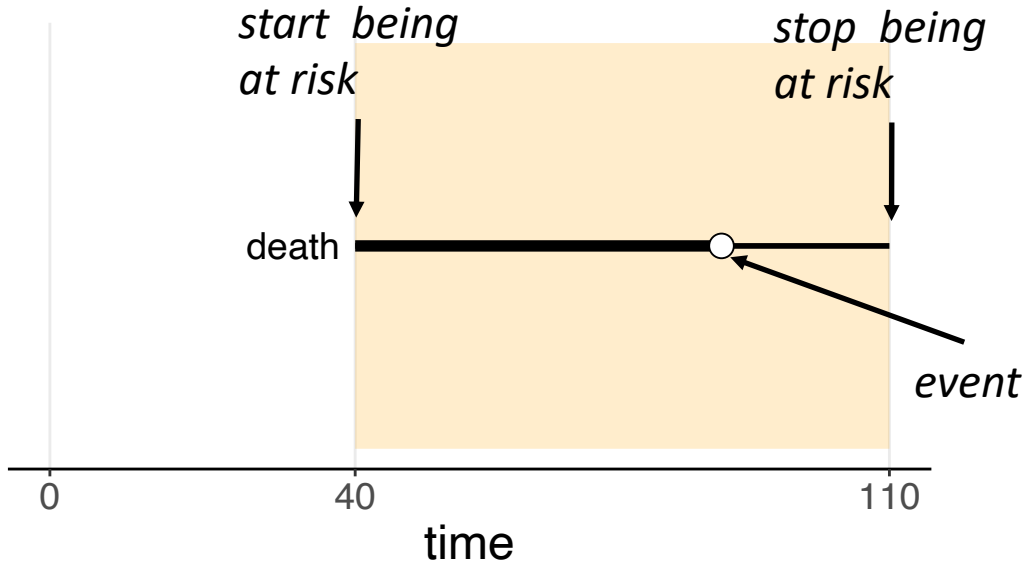
Graphical notation: Exactly one event

Some events shall happen **exactly once** in the interval of interest.

We use black color for such processes.

Example:

- death from all causes



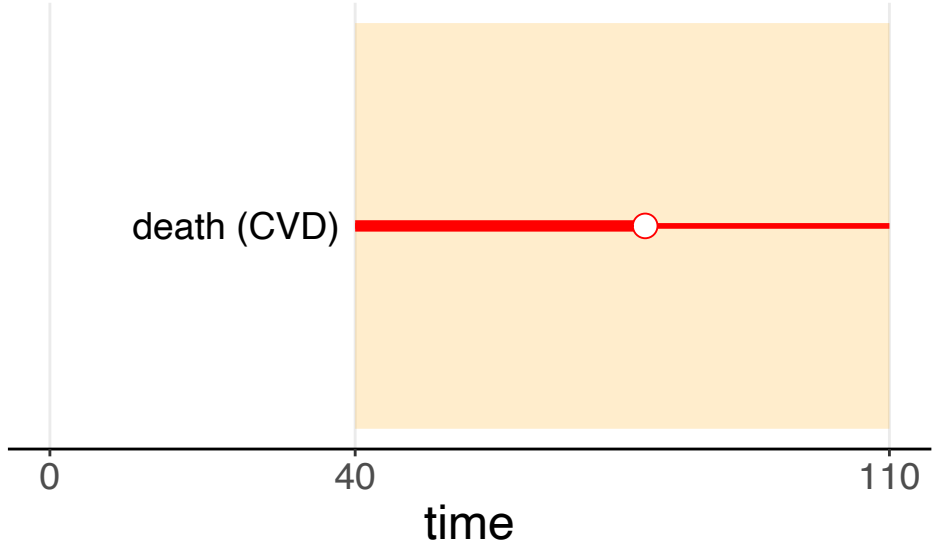
Graphical notation: At most one event

Some events shall happen **at most once** in the interval of interest.

Note, color red.

Example:

- Death from cardiovascular disease (CVD) occurred at age 78



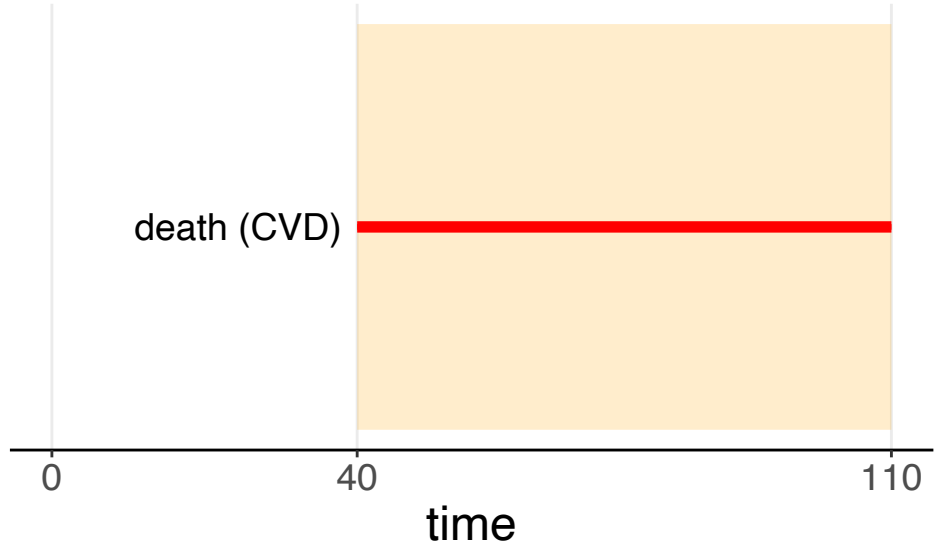
Graphical notation: At most one event

Some events shall happen **at most once** in the interval of interest.

Note, color red.

Example:

- No death throughout the at-risk interval



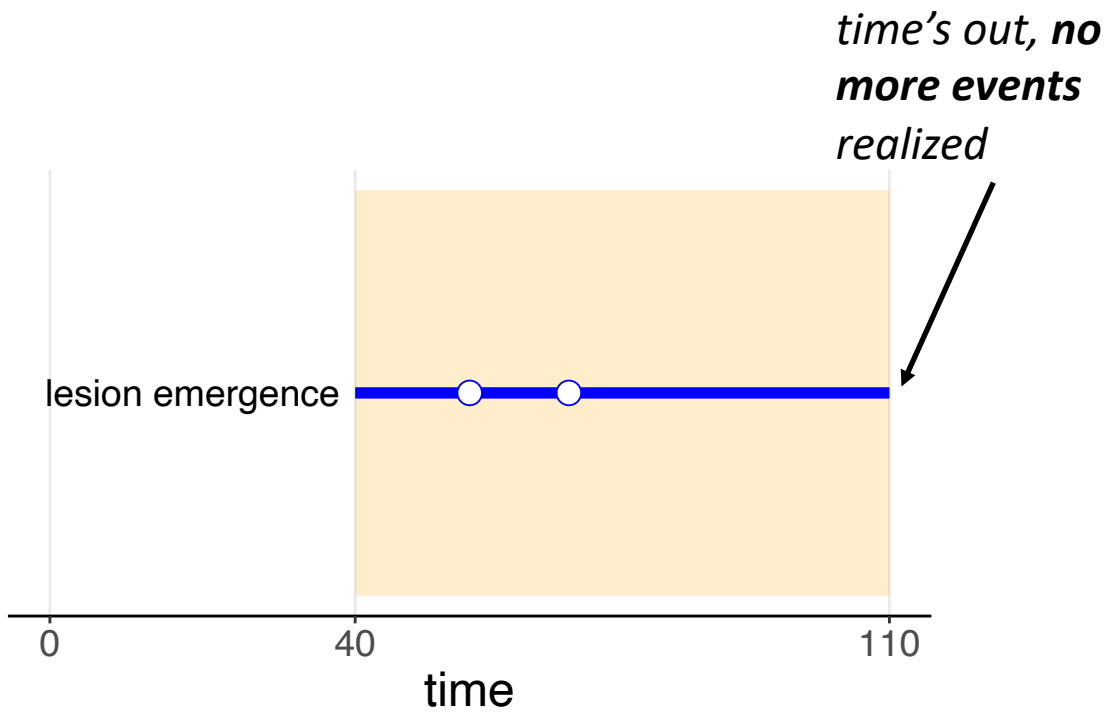
Graphical notation: Zero, one, or more events

Some events may happen zero, one or more times in the interval of interest.

Note, color blue.

Example:

- Occurrence of lesions at 55 and 68 years



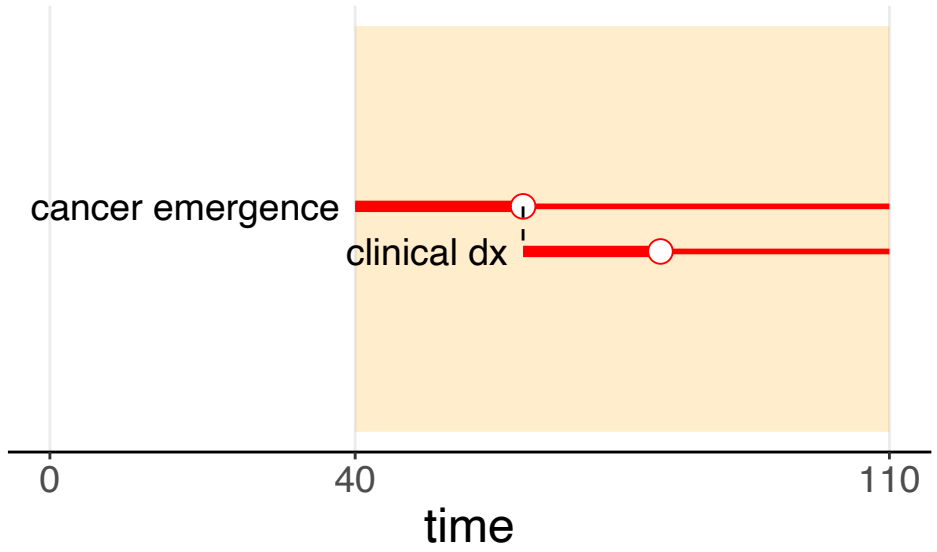
Graphical notation: Chained events (in series)

For chained processes, the next one starts once the preceding one realizes an event.

Example:

- Clinical cancer diagnosis happens at 80, but the process starts only after cancer has emerged at 62

imagine simulating the first row first, etc.

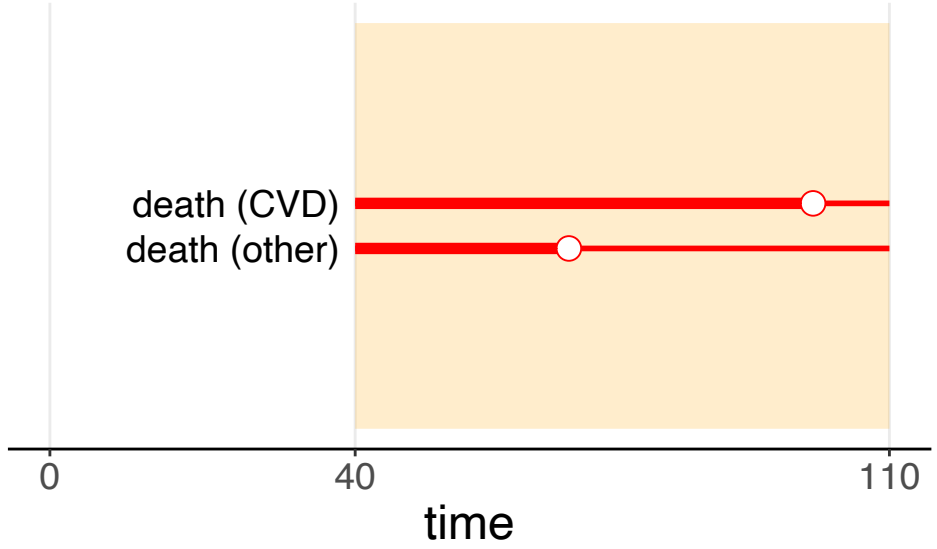


Graphical notation: Competing events (parallel)

Competing event processes run parallel to each other.

Example:

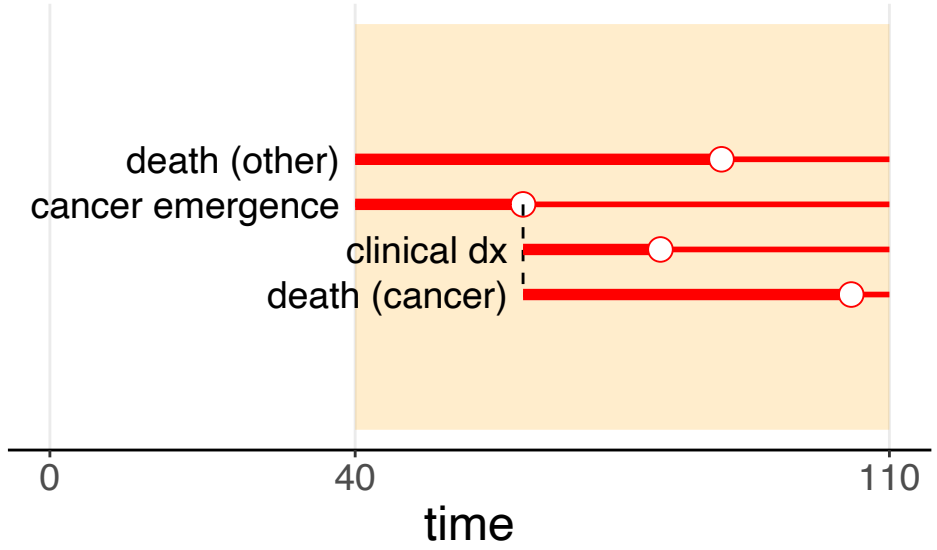
- Death from CVD at 100, death from non-CVD causes at 68
- The age of all cause death is the earliest occurring event, if any (no guaranteed death in interval)



A simple DES model

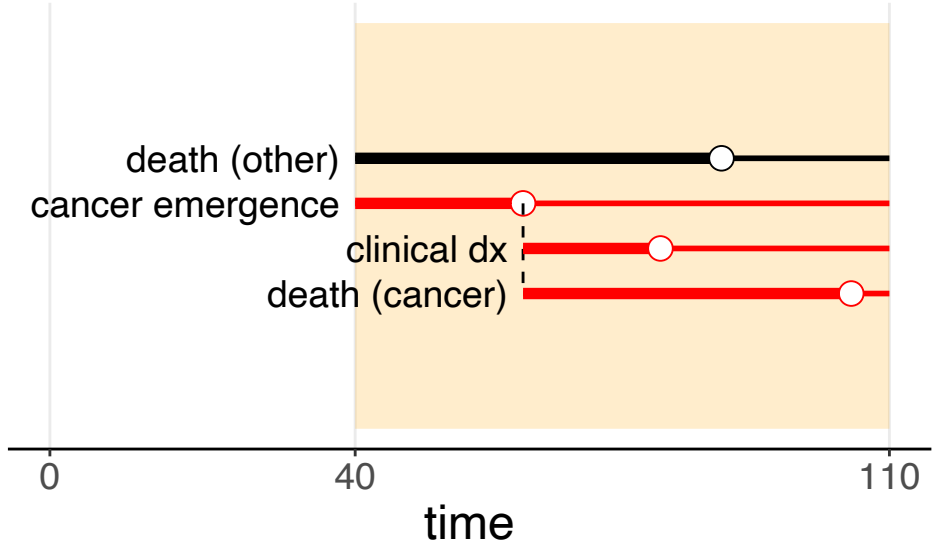
A DES model comprises the black, red, and blue processes, connected in series or in parallel, with proper accounting of start and stop ages.

- What does the modeler assume in this example?

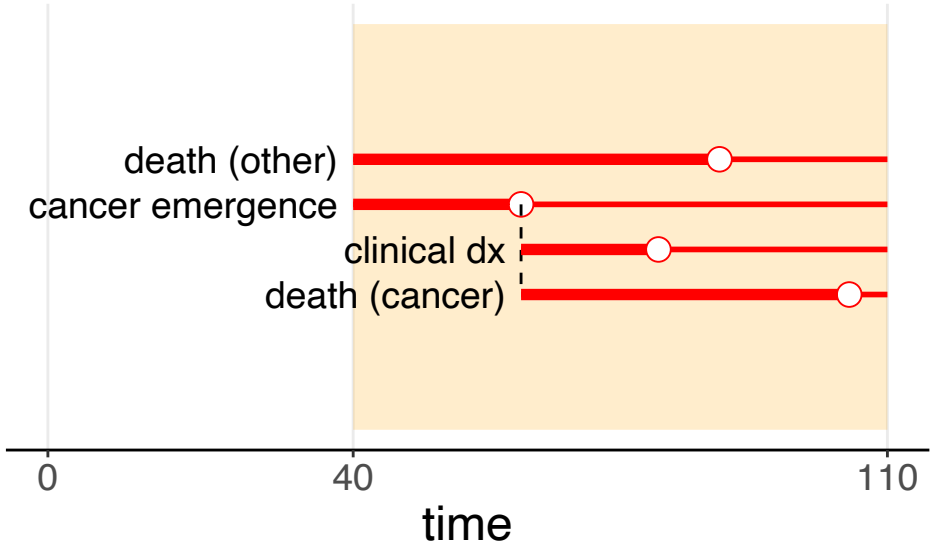


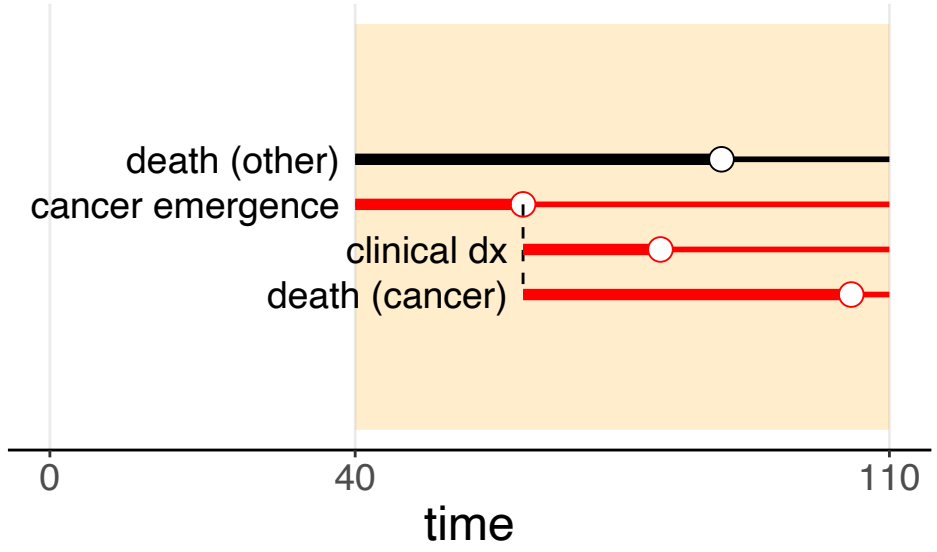
Another simple DES model

- What does the modeler assume in this example?

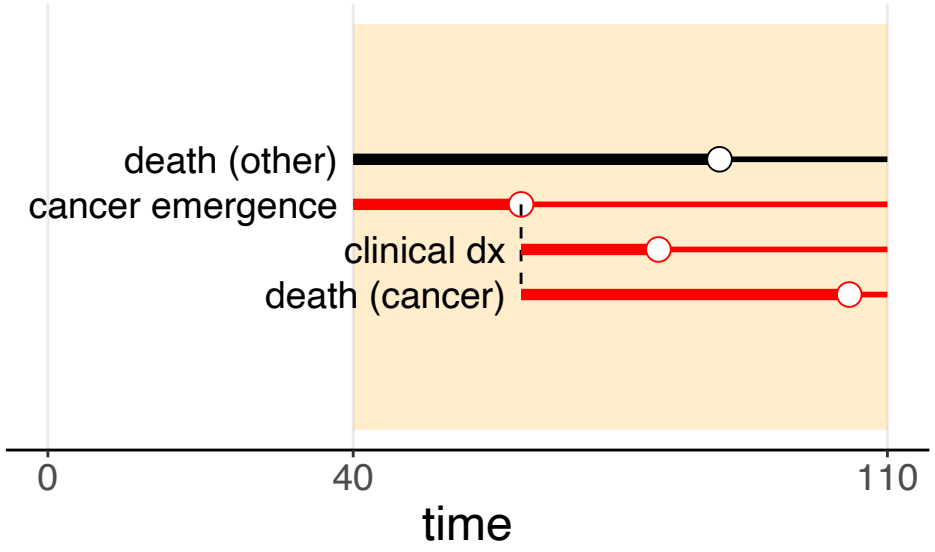


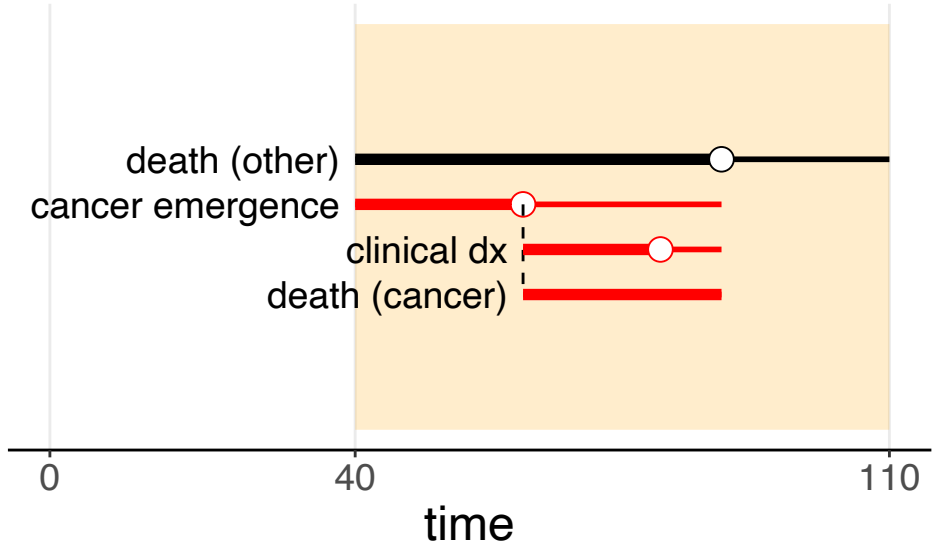
The two examples side by side





Cancer death: what at-risk interval was chosen?



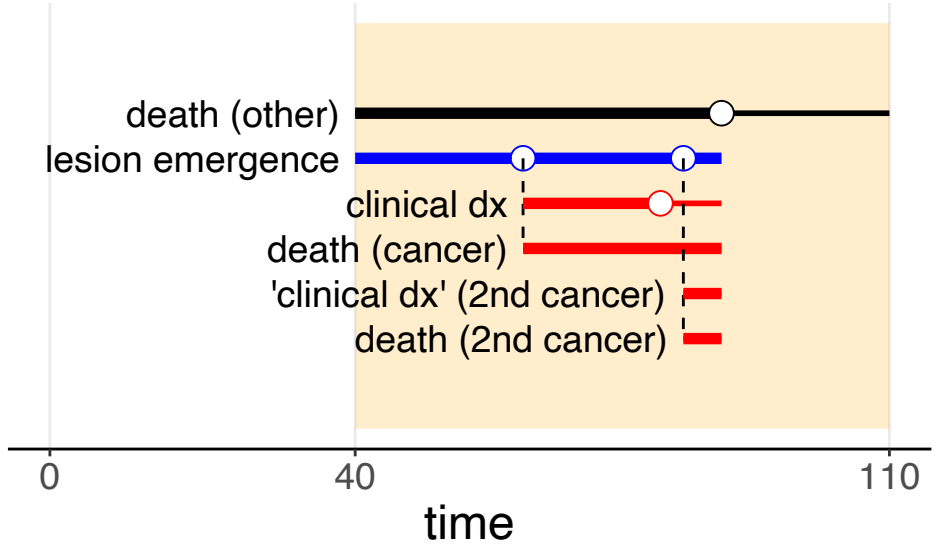


What would a model with multiple tumors look like?

A model with multiple tumors

Many architectures are possible.

What are the risk intervals for each event process?

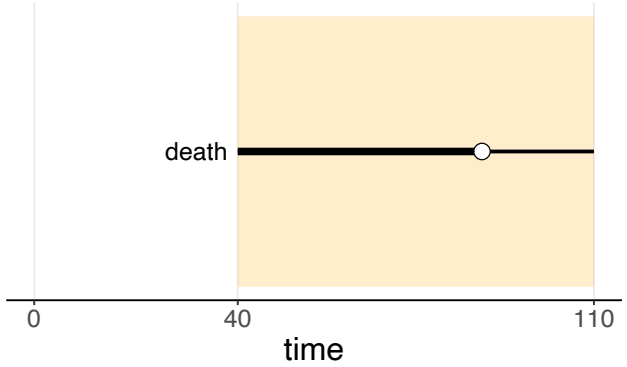


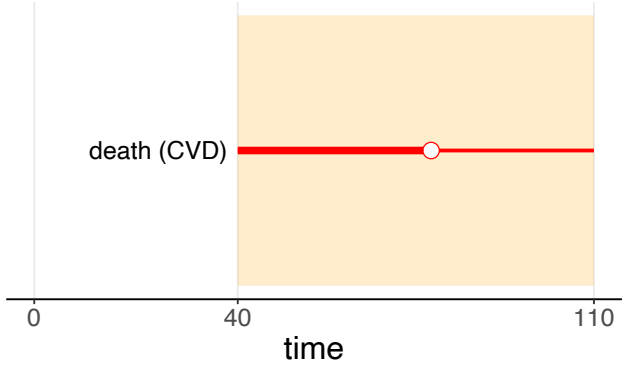
The building blocks of a DES

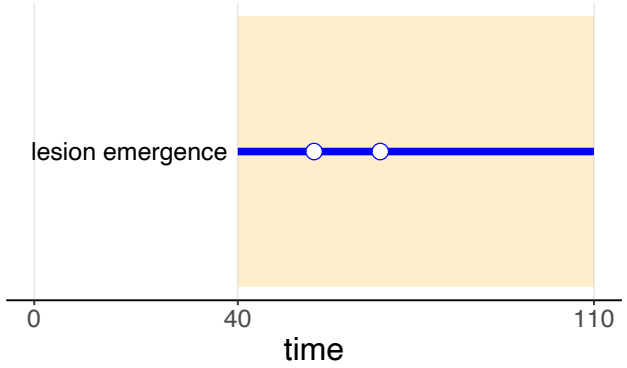
Events that happen exactly once

Events that happen 0 or 1 times

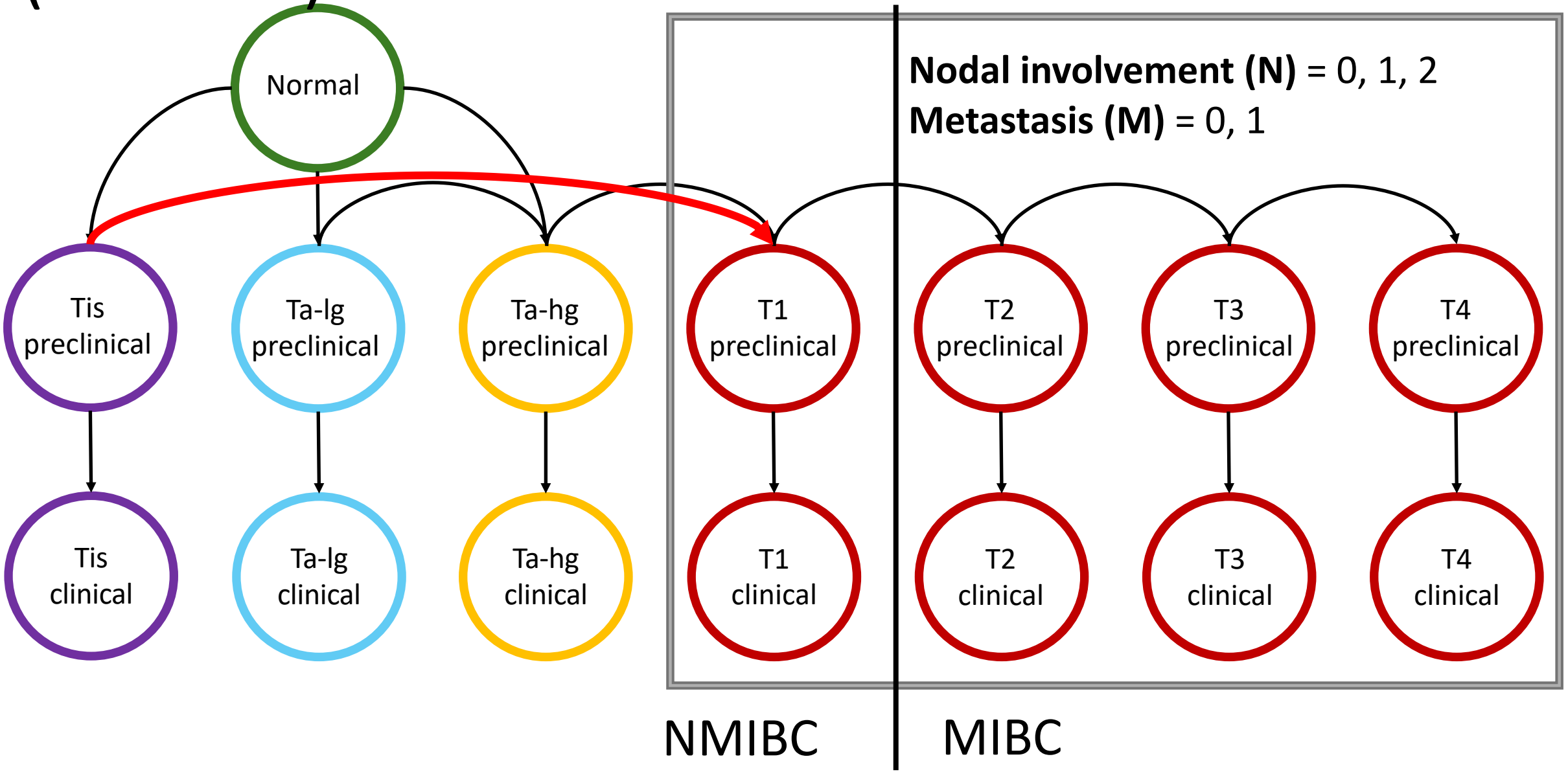
Events that happen 0, 1, … times







Cancer of the Bladder in R Analytic Simulator (**COBRAS**) model



Next … Section 2: Theory

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