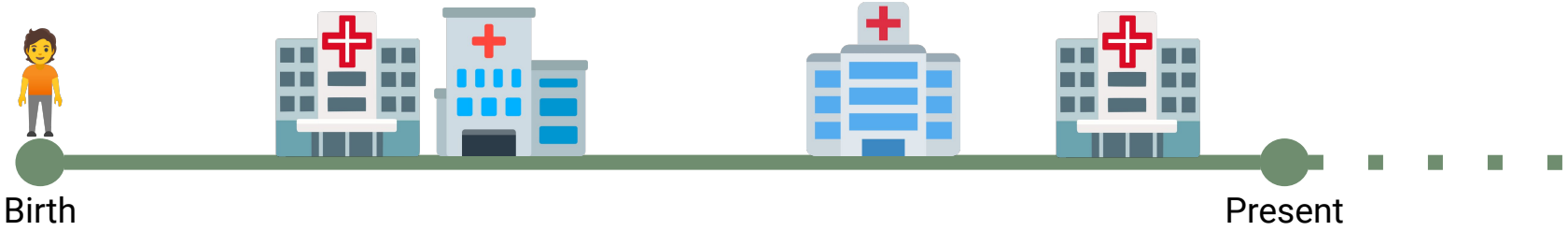
Individual Survival Distributions and the **Hospital**

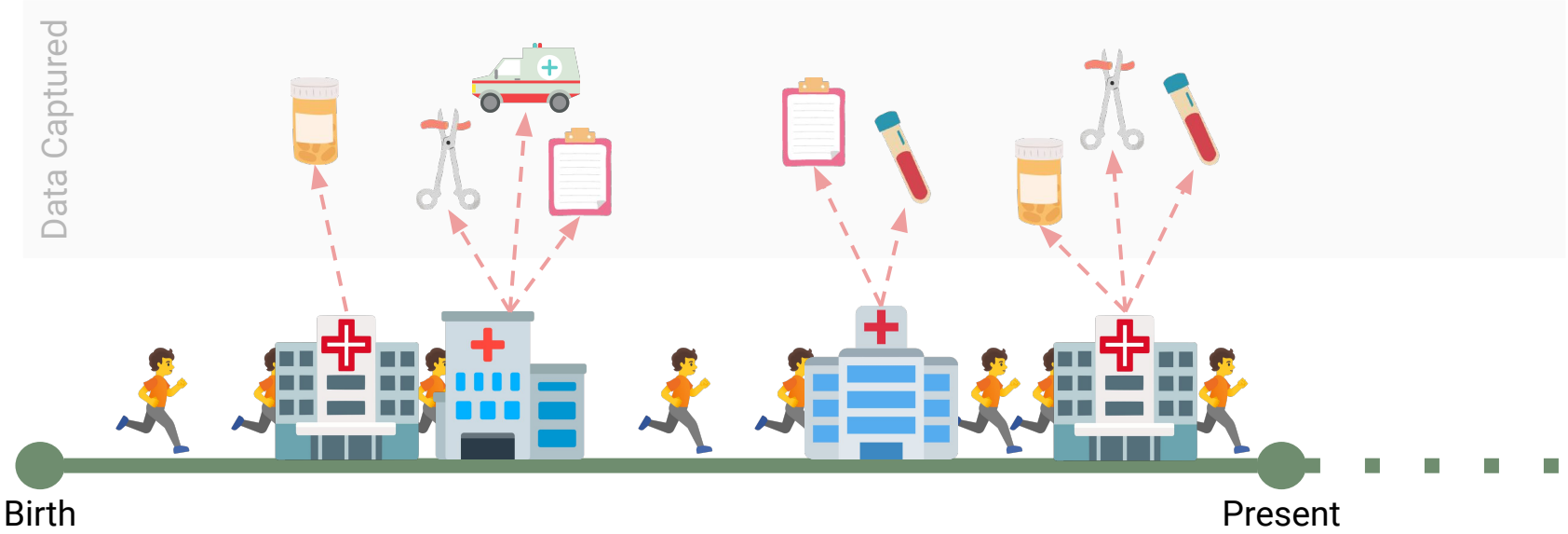
Sacha Davis

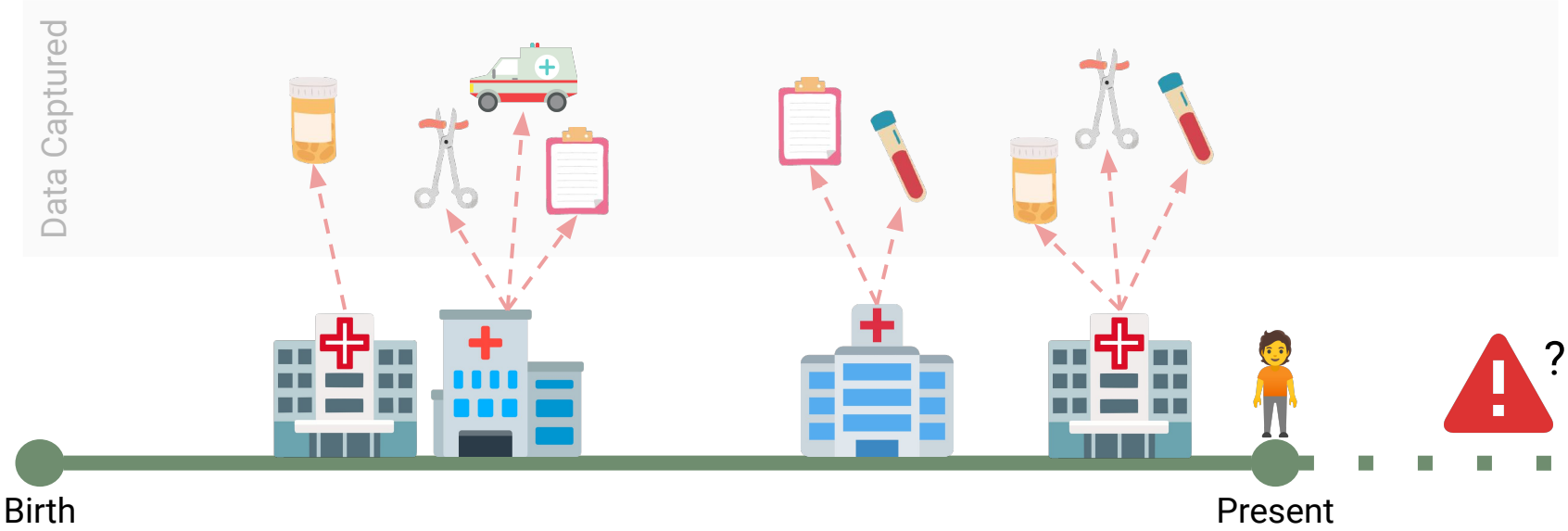
May 05 2023

UNIVERSITY OF ALBERTA

Data Captured



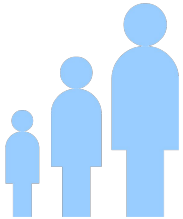

Data Captured
Birth
Present

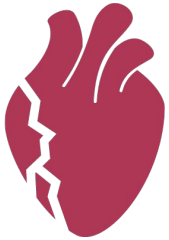


Use the wealth of historical health data we have…

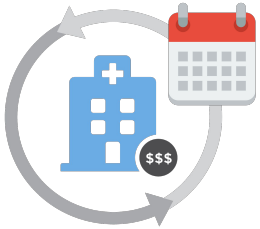
… to gain insights into the potential future of a patient to improve care overall.

Problem #1: Definitions







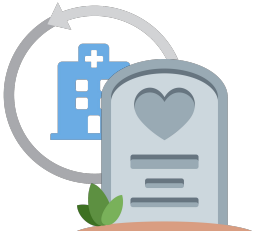


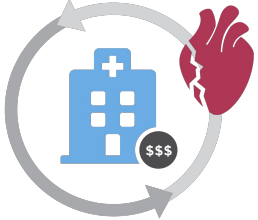
Who?



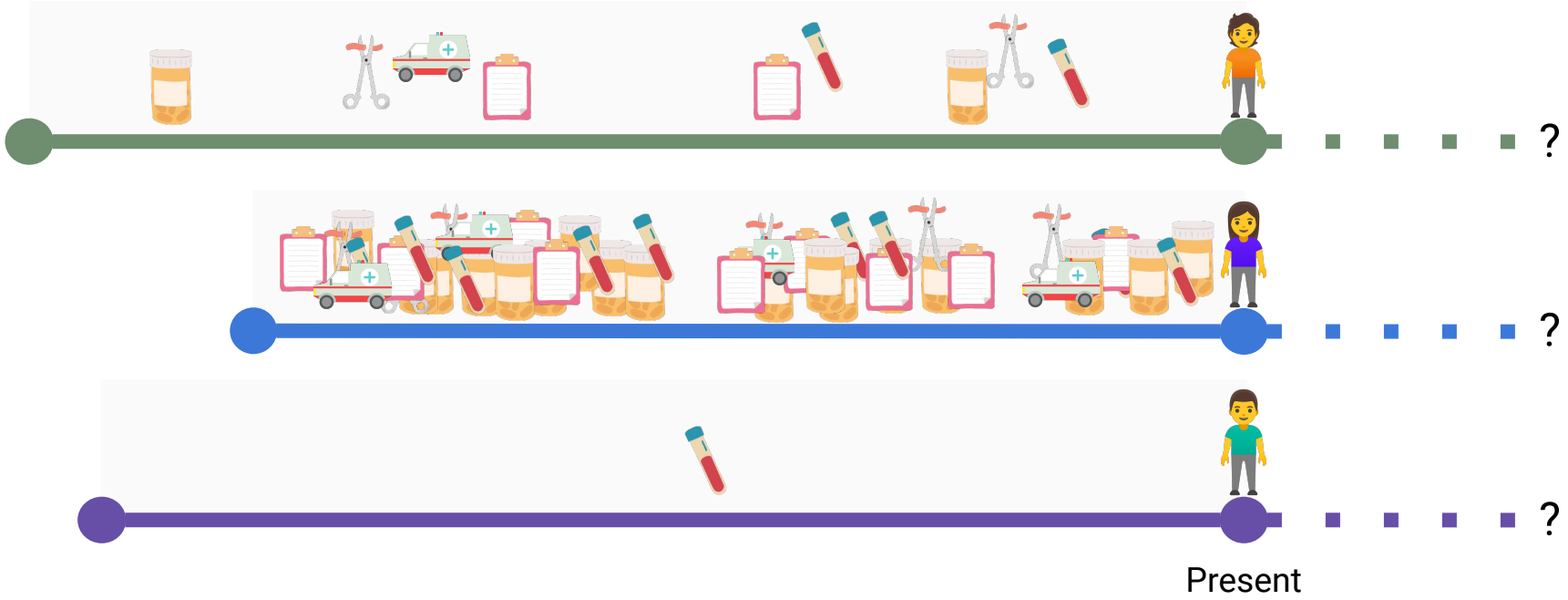


What?

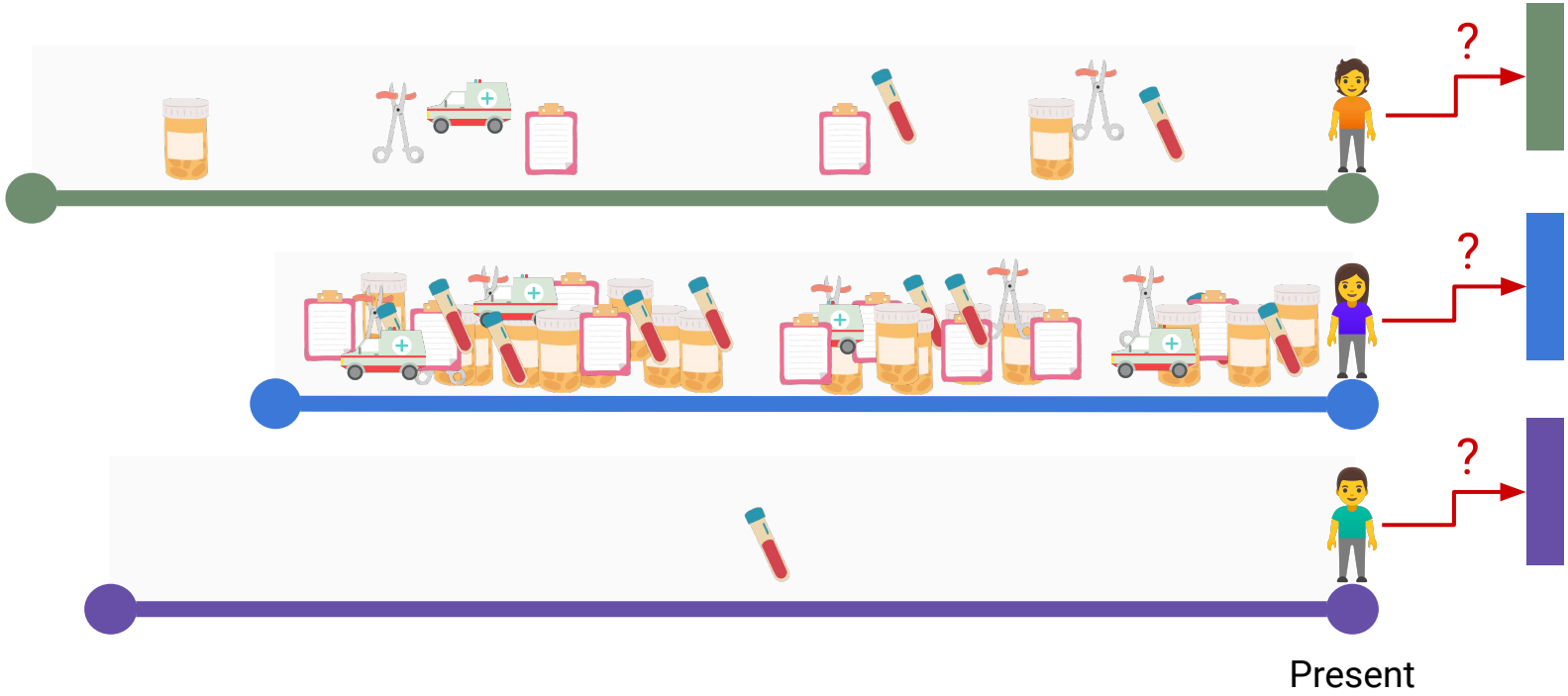




Problem #2: Representations



Problem #2: Representations



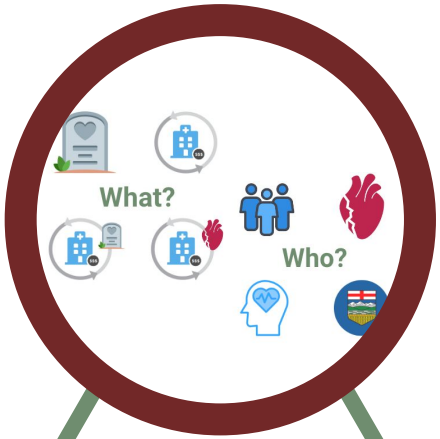
Problem #3: Outputs

What information about the adverse event do we want to provide with our answer?

When would make the most sense to generate the prediction?

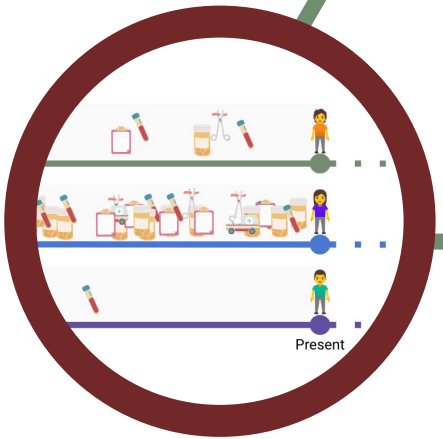
How would one use the model? How are we going to convince people it's useful? Is it useful?





Problem #1

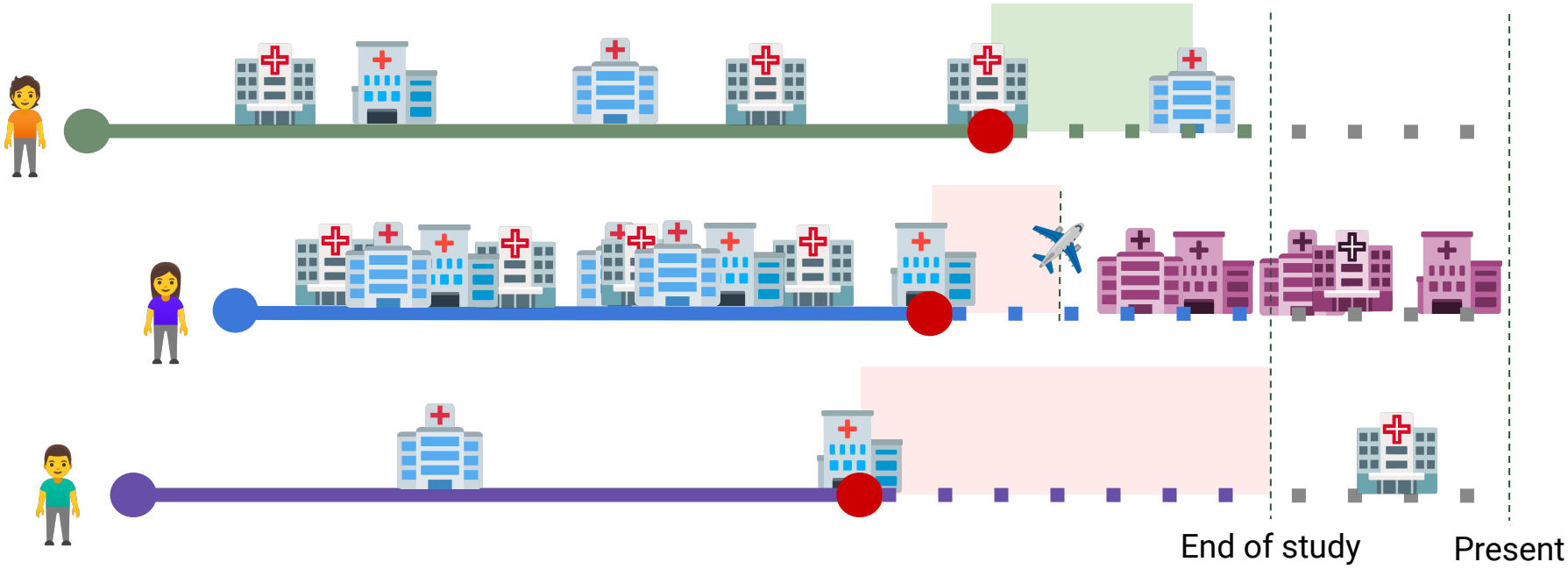
Problem #2



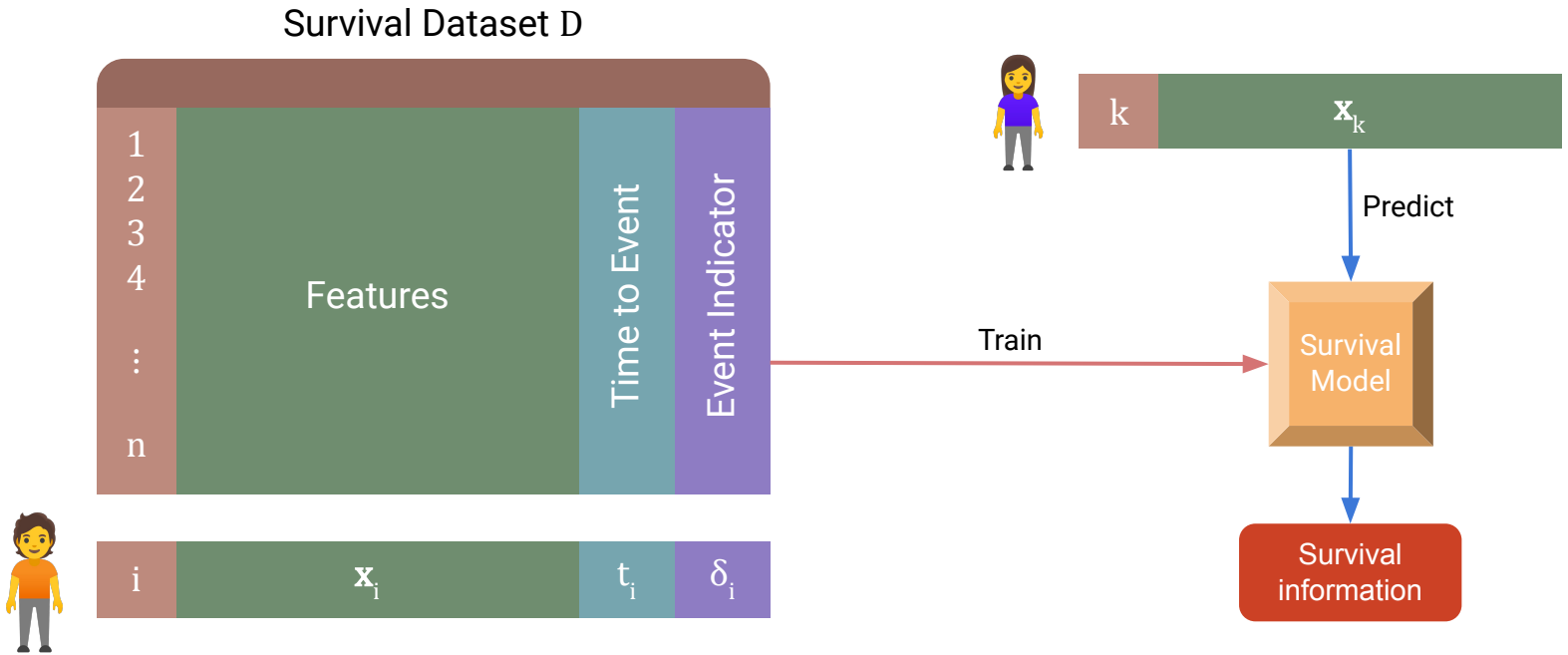


Problem #3

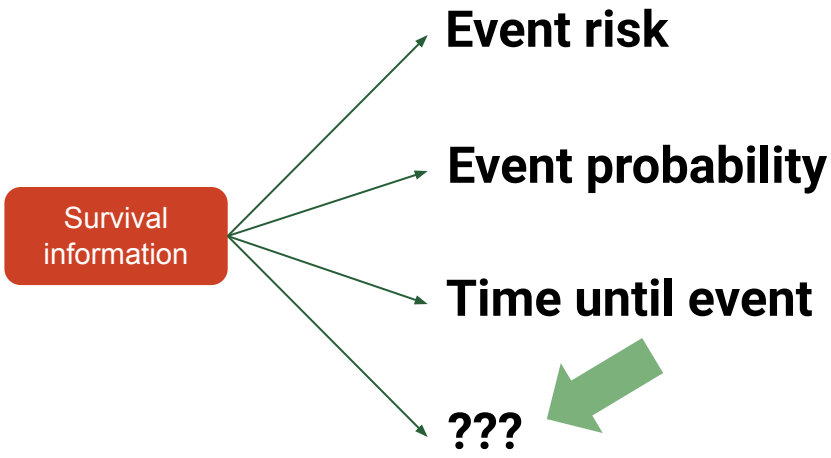
What is survival prediction?



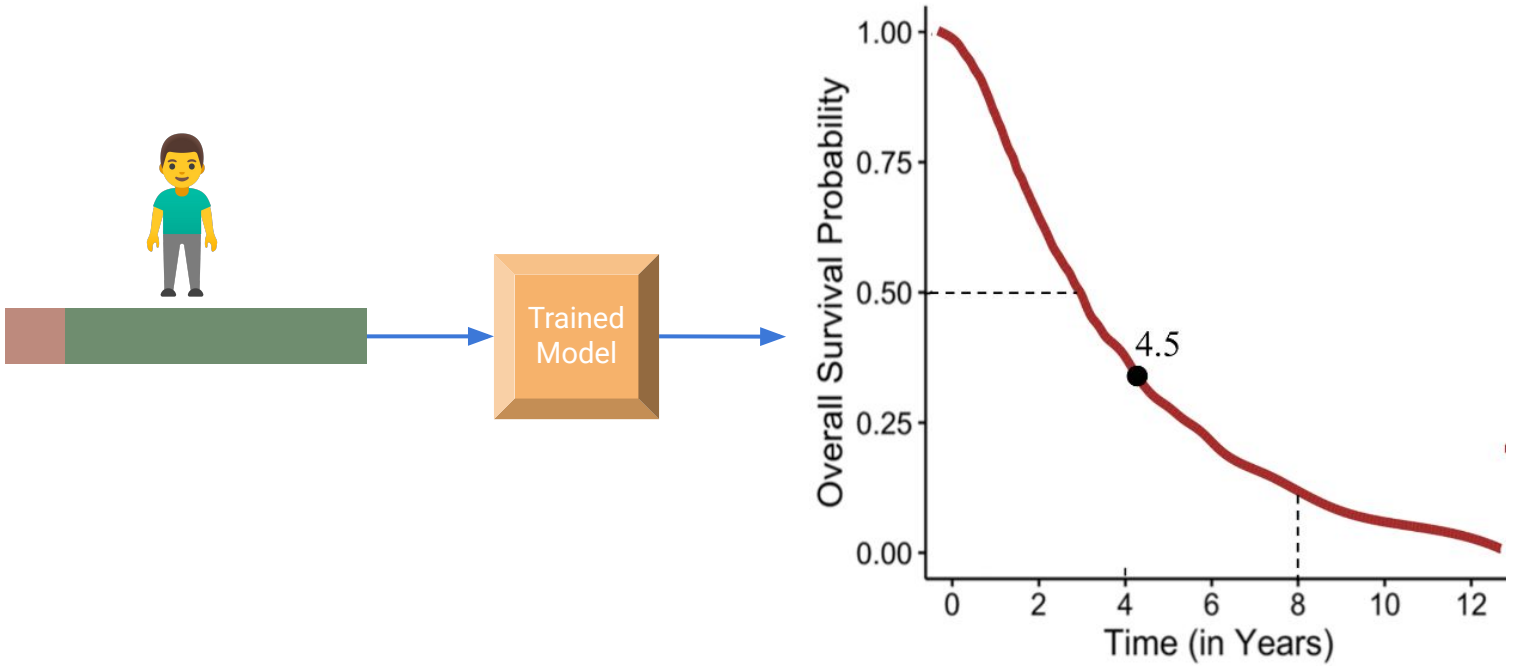
What is survival prediction?



What to predict?

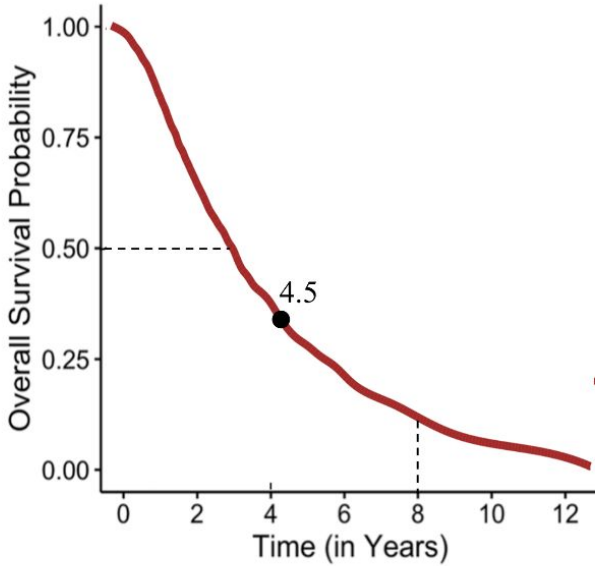


Individual Survival Distributions

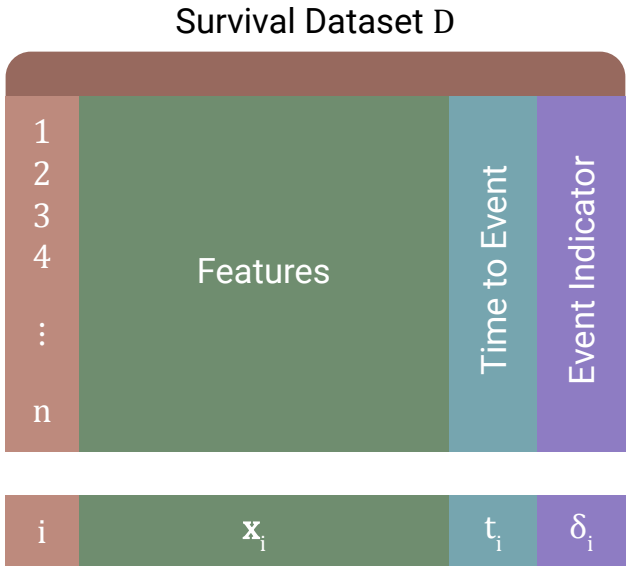


Merits of an ISD

- Visual and intuitive
- Standalone
- **Captures most flexible information**
  - can slice for more granular details (risk score, P(survival) @ time, time-to-event)
  - can aggregate for population level information (akin to KM curve)



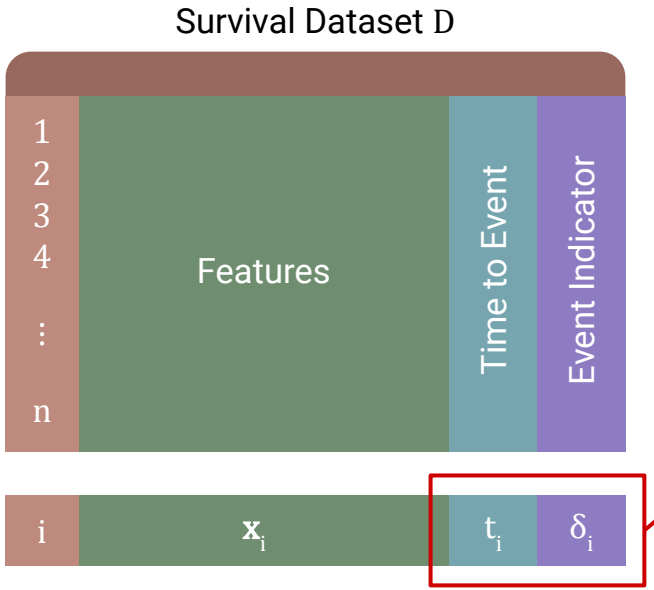
MTLR predicts ISDs



1. Split time into J intervals

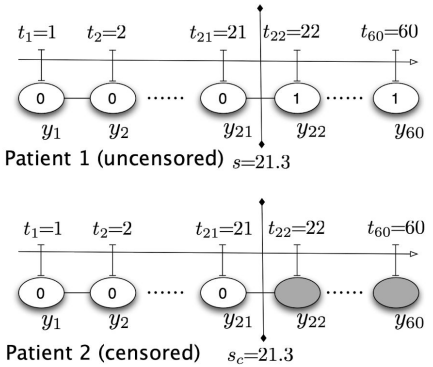


MTLR predicts ISDs



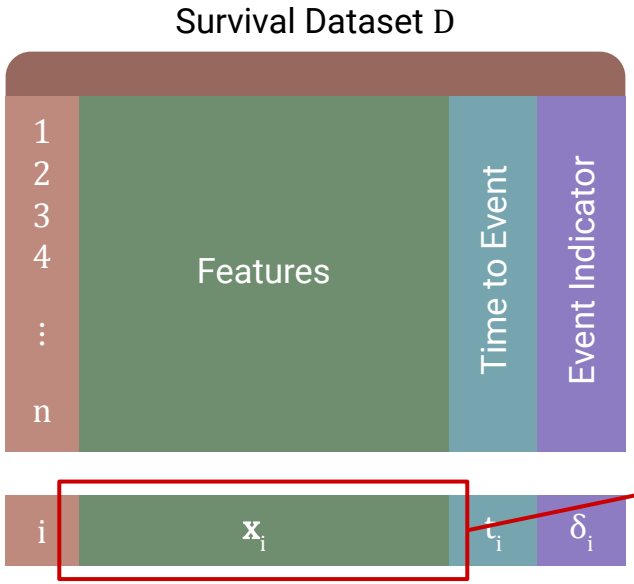
1. Split time into J intervals
2. Encode time & event indicators in $\mathbf{Y}$

$$\vec{Y} = \begin{bmatrix} y_1 = 0 \\ y_2 = 0 \\ \vdots \\ y_{s-1} = 0 \\ y_s = 1 \\ \vdots \\ y_J = 1 \end{bmatrix}$$

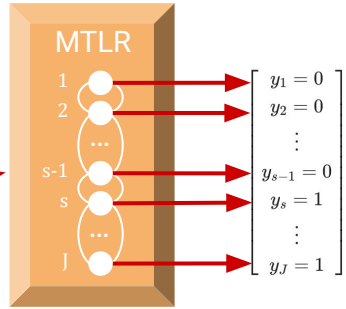




MTLR predicts ISDs

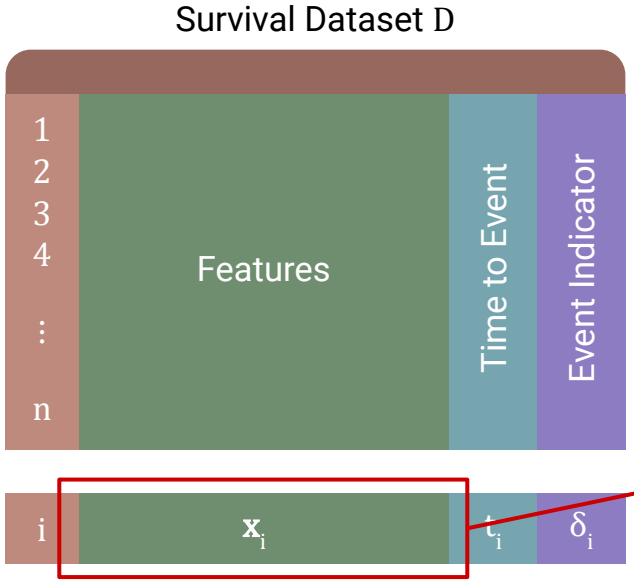


1. Split time into J intervals
2. Encode time & event indicators in $\mathbf{Y}$
3. Train J dependent logistic regression models to predict $\mathbf{Y}$

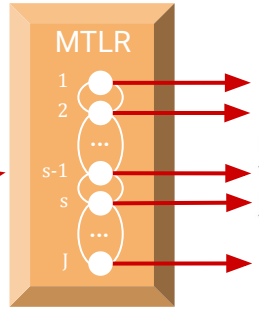


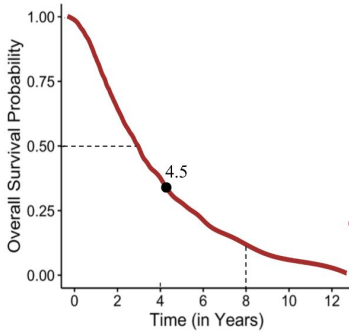


MTLR predicts ISDs



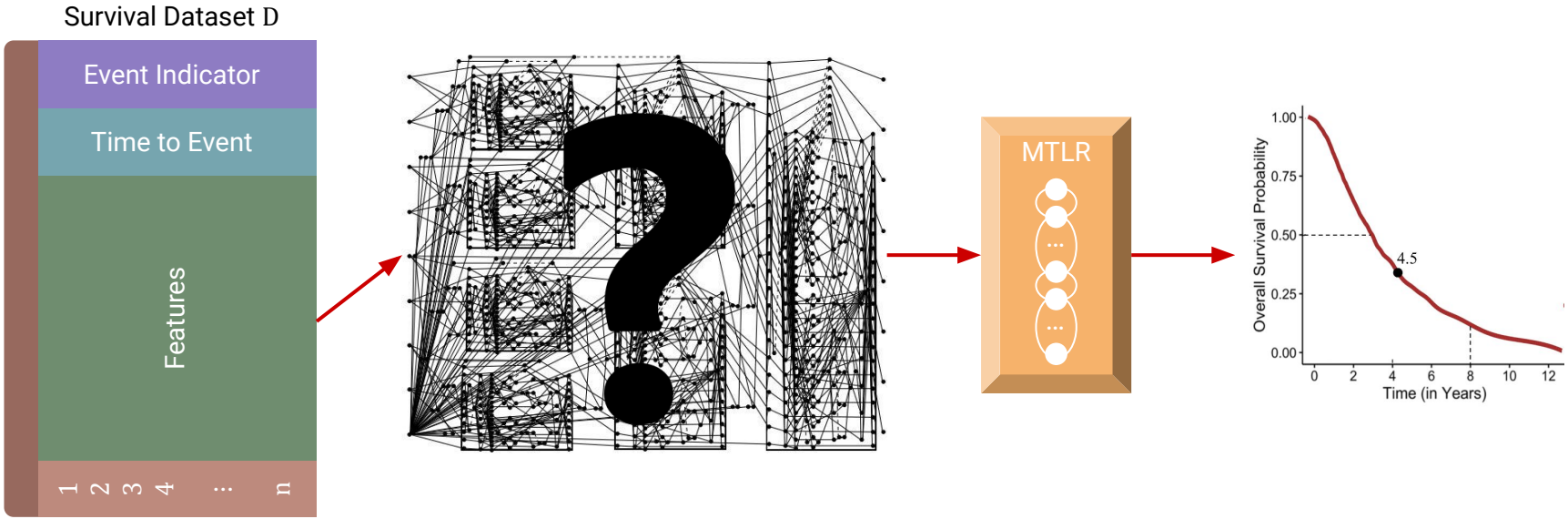
1. Split time into J intervals
2. Encode time & event indicators in $\mathbf{Y}$
3. Train J dependent logistic regression models to predict $\mathbf{Y}$
4. Plot!





$\tau_0 = 0$ τ_1 τ_2 τ_3 τ_{J-1} $\tau_J = \infty$

Neural MTLR


Survival Dataset D
Event Indicator
Time to Event
Features
1 2 3 4 ... n
MTLR
1.00
0.75
0.50
0.25
0.00
Overall Survival Probability
4.5
0 2 4 6 8 10 12
Time (in Years)

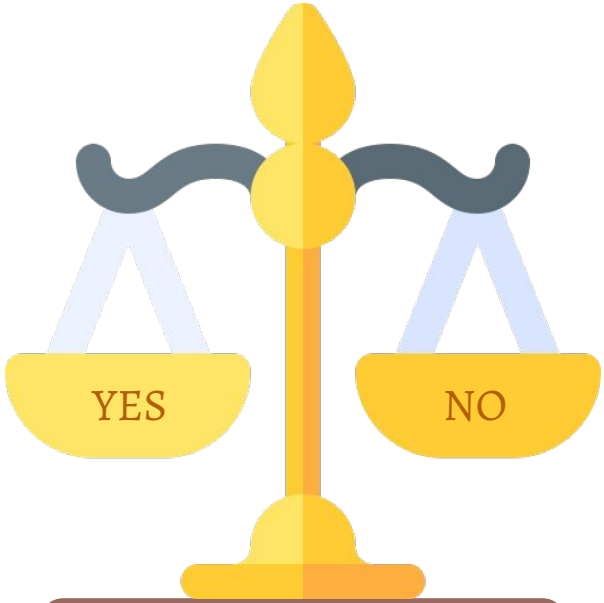
So ISDs are everywhere, right?

…right?



What *is* medical ML's issue?





"Should we adopt this AI model?"



Representing vs. Recommending

This patient is at high risk for readmission!!

Model

This patient will be readmitted in 40±10 days!!

Model

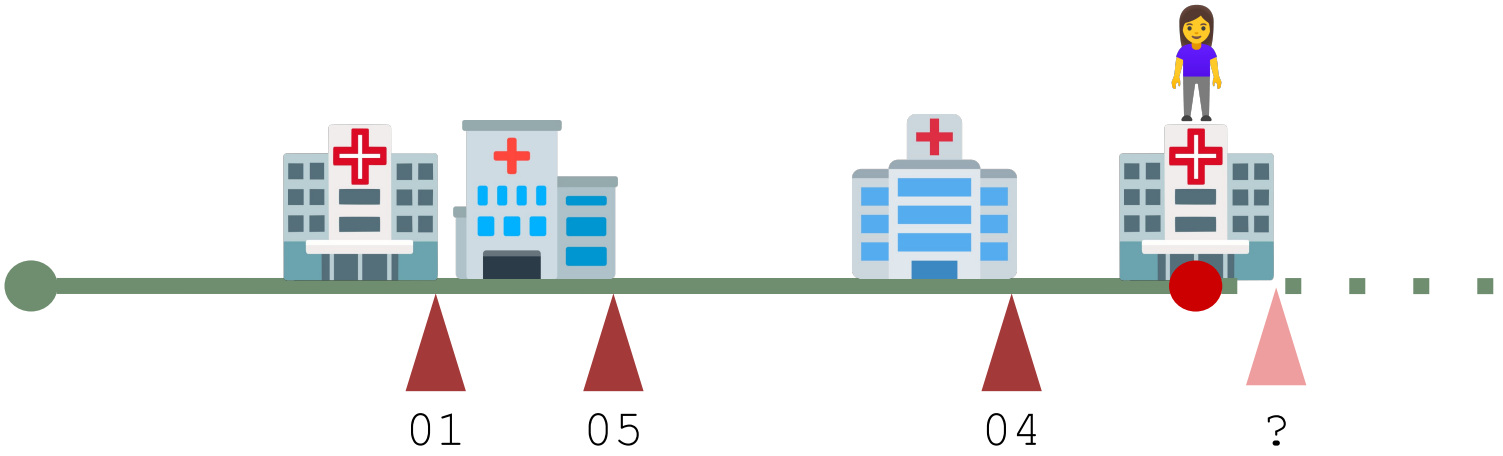
Do **this** to prevent a patient's readmission!!

Model

I'm listening…



Discharge Disposition



Can we use our ISDs to recommend an “optimal” discharge disposition for the patient using counterfactuals?

Discharge Disposition

Discharge Disposition

01: Transferred to an acute care inpatient institution

02: Transferred to Continuing Care

03: Transferred to Other Facility

04: Discharged to home or home setting with support services

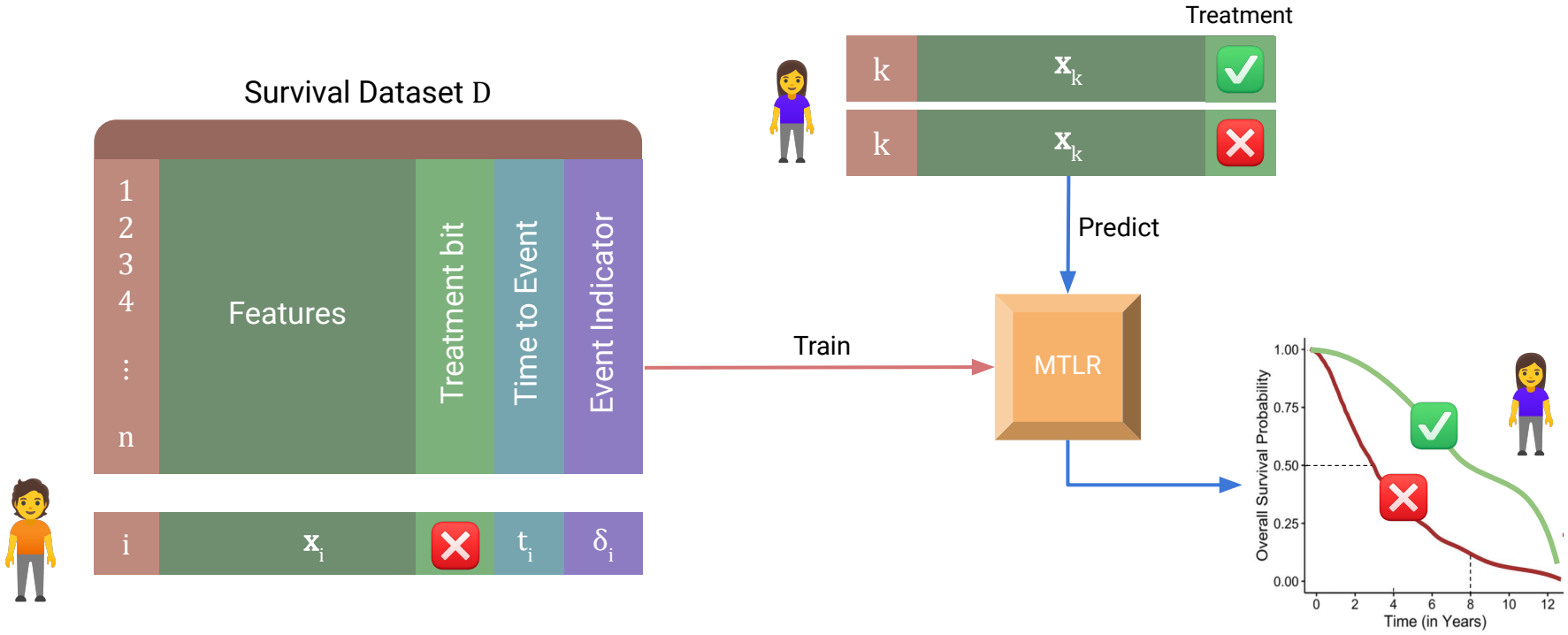
05: Discharged home (no support services required)

06: Signout (left against medical advice) & AWOL (absent without leave)

07: Died

12: Patients who do not return

Counterfactual Treatment Effects

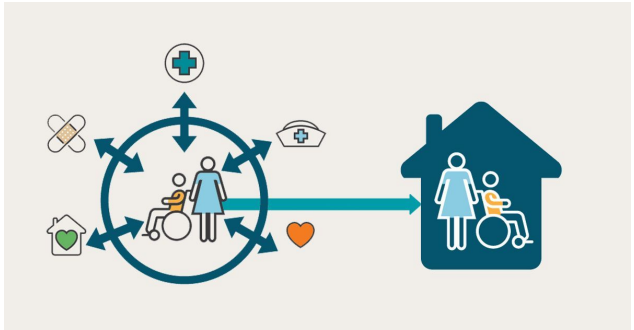


Question:

By how many days would various support services @ discharge prevent readmission?

Goal:

Tell physician `disp` that will maximally keep patient from readmitting.



01: Transferred to an acute care inpatient institution
02: Transferred to Continuing Care
03: Transferred to Other Facility
04: Discharged to home or home setting with support services
05: Discharged home (no support services required)

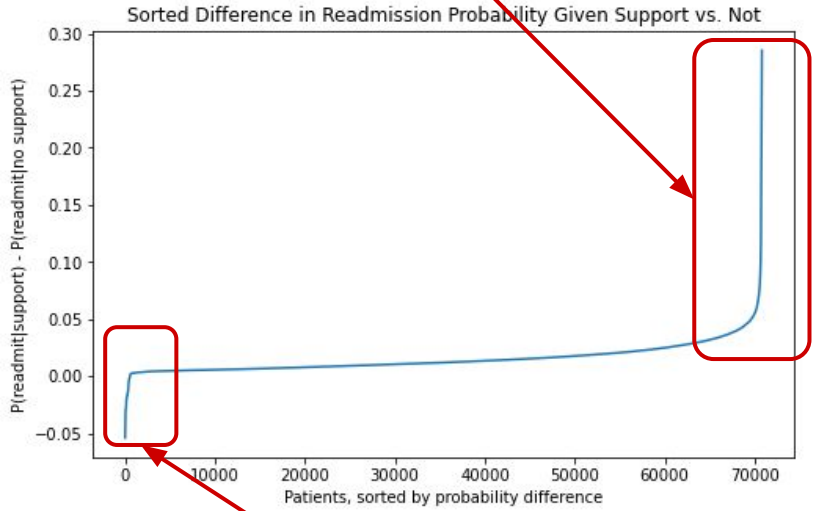
Question:

By how many days would various support services @ discharge prevent readmission?

Goal:

Tell physician `disp` that will maximally keep patient from readmitting.

Patients who would be… more likely to be readmitted if they were given support services?



Patients who would benefit from support services… ?

Bonus Case:



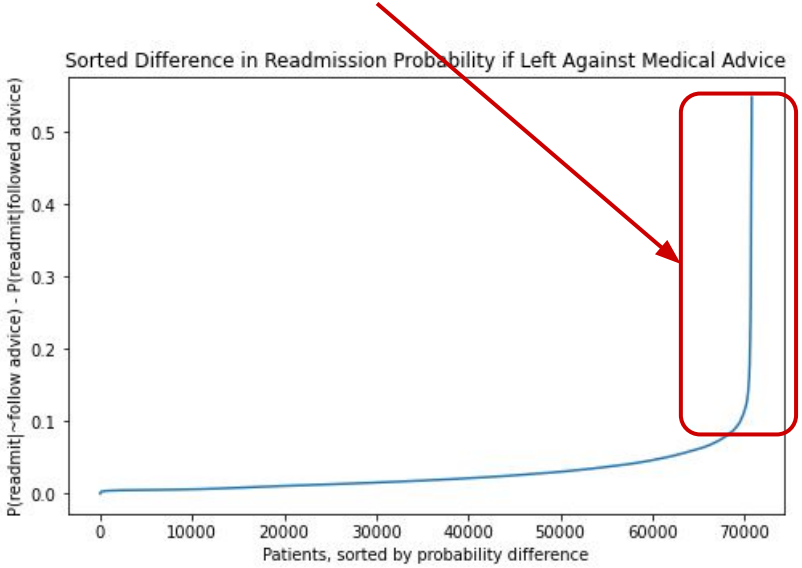
01: Transferred to an acute care inpatient institution
02: Transferred to Continuing Care
03: Transferred to Other Facility
04: Discharged to home or home setting with support services
05: Discharged home (no support services required)
06: Signout (left against medical advice) & AWOL (absent without leave)

Question:
If a patient decides to leave against medical advice, by how many days would time-to-readmission decrease?

Goal:
Help physician convince patient to stay if necessary.

Bonus Case:

Patients whose probability of readmission increases if they leave AMA



Question:
If a patient decides to leave against medical advice, by how many days would time-to-readmission decrease?

Goal:
Help physician convince patient to stay if necessary.

How useful do you think these models actually are?

How can we best package ISDs for clinical use?

Best practices for using counterfactual data in this way?

Thoughts on representing vs. recommending?

Open Discussion

Thank you!



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