Evaluating Survival Prognosis in the Presence of Immortal Time Bias

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slides: goo.gl/khDyZV

Data and Motivation

- Data analysis: Survival times for patients recruited based on a first primary melanoma.
- Observational study: n_2 patients develop a second primary melanoma prior to death.
- **Question:** *How does a second primary melanoma change the survival prognosis?*

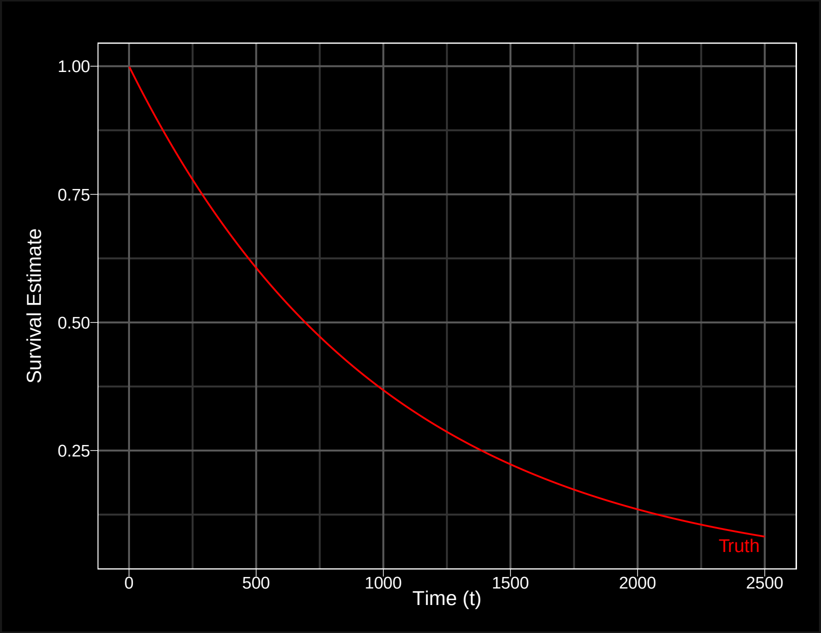
Data and Motivation

- *Problem:* Efficiently estimate survival prognosis for a data structure while avoiding immortal time bias.
- *Why?* Little attention in statistics, major problem in medicine.
- We employ and compare
  1. Cox proportional hazards with time-varying covariates,
  2. Several variations of the the Kaplan–Meier estimator.

Methodology — Cox Regression

- Cox model: proportional hazards assumption.
- $\lambda\left(t; Z = z\right) = \lambda_0(t)\exp\left(\beta^T z\right), \quad t \geq 0.$
- Efficiency by borrowing information across groups.
- *Time-varying covariate* for group transitions.

Results — Cox Proportional Hazards



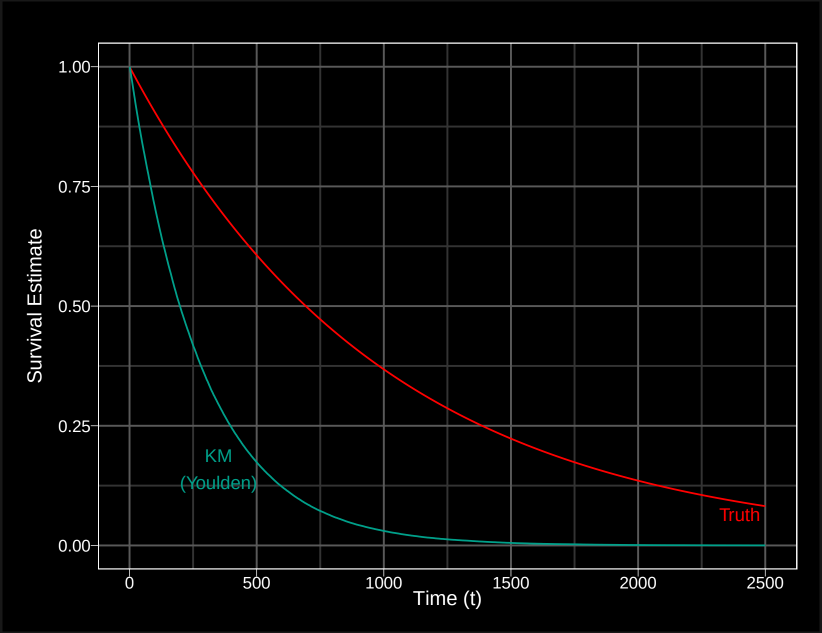
Methdology — Kaplan–Meier (Youlden)

- In pratice, hard to justify Cox model assumptions.
- Nonparametric techniques are less confining.
- The Kaplan–Meier (KM) estimator is defined as

$$\widehat{S}(t) = \prod_{i:t(i)<t} \left(1 - \frac{d_i}{n_i}\right), \quad t \geq 0.$$

- *Proposal:* Fit KM for patients with only 1 melanoma.

Results — Kaplan–Meier (Youlden)



Methdology — Kaplan–Meier (Jewell)

- Striking difference between Kaplan–Meier and Cox.
- Why is Kaplan–Meier so sharply biased?
- Better way to estimate survival nonparametrically?
- Modify Kaplan–Meier to obtain accurate estimates?

Results — Kaplan–Meier (Jewell)